The Chemical Age

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Notes and Comments

Training for Industrial Research

THE council of management of the British Science Guild has rendered a public service by including in its annual report, presented at the annual meeting of the Guild on June 12, the text of the preliminary memorandum on the development and finance of the Department of Scientific and Industrial Research and its allied research associations, drawn up by a specially appointed joint committee of the British Science Guild and the Association of Scientific Workers. The broad financial problems which beset the Department are more or less familiar, but in the memorandum to which we refer, the joint committee raises the important question of the University training of the future investigator in industrial research.

We agree that while the financial arrangements of the Department of Scientific and Industrial Research are being overhauled the opportunity should be taken to examine the general organisation with a view to introducing any additions or alterations to the general structure which experience suggests are necessary. One proposal is that some use might possibly be made of the Mellon Institute type of organisation. Whatever the type of organisation adopted, the need for a larger measure of elasticity appears to need no argument. In such work the most important, if not the main, questions are (1) to find the right men with a genuine bent for industrial research, and (2) to provide them with the right sort of education for work in the research associations. Such men must possess pluck, self-reliance and character. They must also regard a career in industrial research as a great adventure rather than a search for a safe job.

Eighty per Cent. Casualties

FUTURE investigators in industrial research must be properly trained, not as specialists learning more and more about less and less as they approach the end of their academic career, but with a wide grasp of the main facts and principles of a group of sciences and with a competent knowledge of the sources of information and the capacity to marshal facts and to set them out in writing. In the main work of their lives they will constantly have simultaneously to bring knowledge to bear from many sides of the problem in hand, for the simple reason that many of the questions they will have to investigate do not fall within the boundaries of any particular science, but often overlap into several others. The ordinary specialised academic training is obviously useless for such work. In some cases it might be positively harmful. Similar difficulties arise in the university training of investigators in medical subjects and in applied biology. The difficulty might be met by some modification of the existing arrangements for scientific education in the universities. The first two or three years could be devoted to a general training on the lines of Part 1 of the Natural Science Tripos at Cambridge which all students would follow. The last year or the last two years would vary with the aims of the student. Academic workers would proceed as at present and pursue their specialist training; applied workers of all kinds (industrial, medical and biological) would take up suitable groups of sciences designed to fit them for their future work. That the present system is not producing the results needed in industry is indicated by the following facts taken from the report of the Department of Scientific and Industrial Research itself. The Department assists in the training of the industrial research workers of the future by means of grants amounting to about £40,000 per annum. In Table 4 of the annual report for 1930-31 the after careers of these students are given:

During the period 1920-25, 37 per cent. went into industry.
During the period 1925-30, 27.5 per cent. went into industry.
During the period 1930-31, 22 per cent. went into industry.

This diminishing percentage is disquieting. It would seem that about four out of every five men specially selected and trained for industry are in a sense casualties.

The Value of Publicity

THERE is another passage in the memorandum of the joint committee of the British Science Guild and the Association of Scientific Workers which not only the Department of Scientific and Industrial Research but certain of the organisations in the chemical profession and industry would do well to ponder. We refer to the statement that almost without exception the research activities of this country have suffered from lack of publicity. The Department of Scientific and Industrial Research, in spite of its admirable annual reports and other publications, is no exception to this rule. One reason for this appears to reside in the system of annual reports itself—a device more suited to the operations of a joint stock company (with its attendant annual dividends or excuses for their non-existence) than for the research worker. A fundamental change appears to be overdue. The annual report should be abolished and replaced by (1) a short statement of important administrative matters to which is

appended a list of publications and an audited statement of income and expenditure; (2) an authoritative news service throughout the year dealing with the results of the researches as they mature; this would greatly help the Press and would maintain public interest; (3) triennial or, still better, quinquennial reports of the operations of the various sections of the Department of Scientific and Industrial Research and the Research Associations. These would be bound volumes suitable for permanent record.

The majority of the technical societies value the publicity they receive in the technical and trade Press and impose no unreasonable restrictions upon the length of reports issued prior to their appearance in full in their own publications, whether issued at long or short intervals. There are still some, however, which because they publish a journal of their own (which obviously only reaches a section of the profession concerned, for no society has yet reached saturation point) impose irksome restrictions on the extent to which papers read at their meetings may receive notice in the technical Press. We wonder whether such societies have ever considered the effect of this policy in relation to the need for arousing the interest of potential members. Adequate publicity in the technical Press is the most effective, if not the only, means of bringing the activities of such societies to the notice of those who ought to be members. Organisations which are at present deploring decreases in membership might reflect upon this possible method of making good the membership losses of recent years.

Research in Physics

LEADERS of the electrical industry frequently point out the benefits that have resulted from co-operative research in the cheapening of electricity. The existence of the immense investigational departments of some of the private companies is common knowledge. One of the most difficult problems is that of insulation, particularly in view of the high voltages employed by the grid. Even with lower voltages there are too many uncertainties for the designer to be happy. The combined result is the placing of transmission lines in positions and circumstances for which they are not entirely suitable, with increased cost to the user. It was with great interest, therefore, that we inspected the new research laboratories just completed by Callender's Cable and Construction Co., designed primarily for the investigation of this problem. They include two huge transformers, each capable of a continuous output of 500 kilo-volt-amperes at 500,000 volts extending upwards to 1,500,000 volts by connecting them in cascade. The chemical industry is greatly interested in the provision of insulation, as the extended use of moulded products shows, and we have no doubt that the work done in these laboratories will involve the co-operation of the chemist. The electrical industry, however, is by no means the only one wherein physics and chemistry overlap. There is no industry free from this overlapping; not even the most severely chemical process can be carried out industrially without the intervention of engineering—and what is engineering but applied physics? It is for such reasons that we deplore the tendency sometimes too much in evidence to divorce these two branches of study. Chemistry, physics and mathematics should be as much parallel branches of study to those embracing a scientific career as are Latin and Greek to the classical student. The International Conference on Physics, which will be held in London in October, may be expected to provide additional evidence of the intergrowth of the sciences and we have no doubt that many of the papers on applied physics at least will be of considerable interest to the chemical industry. The growth of physics entails a corresponding growth in the requirements for new materials; new materials provide the opportunity for the chemical manufacturer.

Records of Business Men and Firms

THE formation of a Council for the Preservation of Business Archives is announced by Mr. Baldwin, Sir Francis Goodenough, Sir Josiah Stamp and others. As men interested in the history of the economic life of this country, they have been struck by the scarcity of an important class of documentary evidence—the records of business men and firms. This scarcity is attributed not only to destruction by fire and accident, but to the elimination of old documents often dictated by shortage of office space. Still, Mr. Baldwin and the other members of the new council have every reason to believe that great masses of economic records still remain completely inaccessible in the possession of firms or of families descended from business men.

The purposes of the new enterprise are to organise information about such records as exist, and to prevent the further destruction of papers which are likely to be of interest to the economic historian. The first object is to map out the ground by compiling a register of all business records over a hundred years old. This is a fascinating field and by no means a small one, as many of our readers can prove from their own experience. When the register is complete it can hardly fail to show how much modern business owes to the individual proprietorship of previous centuries.

Rothamsted Experimental Station

THE ceremony of handing over the deeds of the Rothamsted Experimental Station on June 20, reported elsewhere in this issue, was the outcome of an exceedingly gratifying response to an appeal issued to the public some months ago for £35,000. A good lead was set by Sir Bernard Greenwell with a donation of £1,000; then followed in rapid succession magnificent donations of £15,000 by Mr. Robert McDougall and £5,000 by the Sir Halley Stewart Trust on condition that the remainder was obtained in time. The Royal Agricultural Society, the National Farmers' Union, the Sugar Beet Factories and Imperial Chemical Industries, Ltd., gave substantial leads, quickly followed by all the leading societies and business organisations interested in agriculture at home and overseas, and by many landowners and farmers, both large and small. Students at colleges and scholars in country schools all helped. Generous help was given by the fertiliser and feeding-stuff makers and other users of agricultural products.

The fund was finally closed by a noble grant of £2,000 from the United Kingdom Carnegie Trustees. A new chapter in the history of Rothamsted has thus been opened, and the station enters into its new possession with the gratifying knowledge that it has a generous measure of public support and confidence.

A New Ceramic Ware with a Water Absorption of Nil

By FELIX SINGER, Dr. phil., Dr.-Ing., F.A.C.S.

THE acid resisting properties of stoneware have been known and appreciated for centuries. In more recent years there has been a demand in the chemical and allied industries for ware of a greater density, and finally for a ware with a water absorption of nil. The reason for this is apparent. First of all, higher standards of production have been required from the chemical industry itself, particularly in regard to greater purity and the utmost possible yield. These qualities are more and more required from chemical preparations.

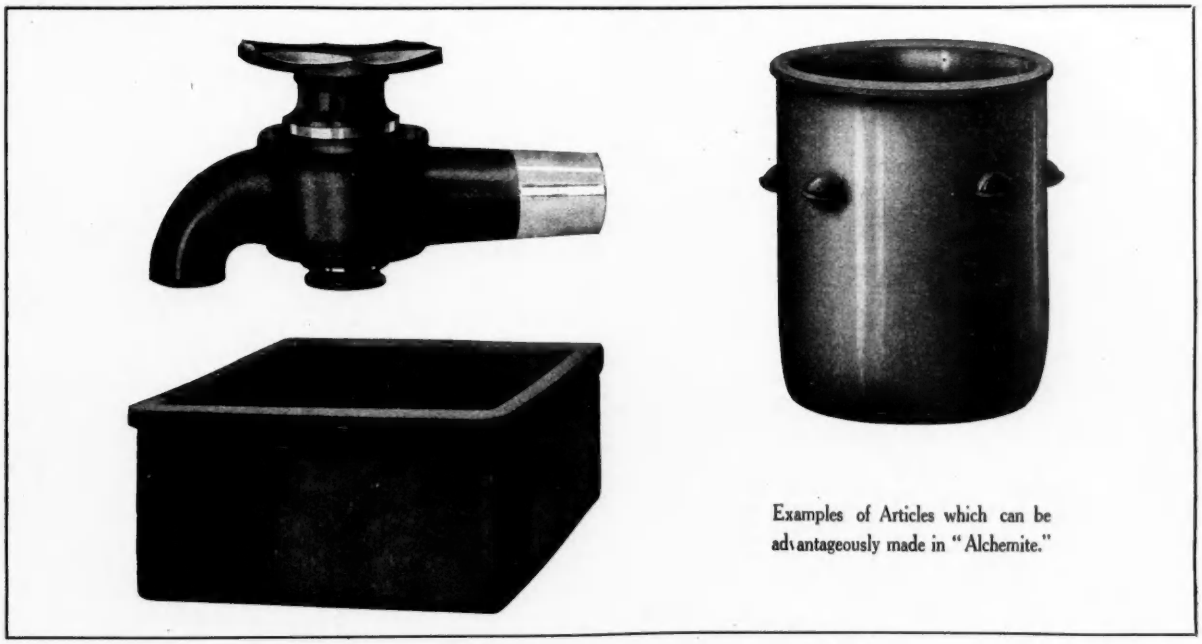
Absolute uniformity in the different " charges " is now an essential condition of manufacture. This, however, is only possible if the apparatus in which the preparation is made is under complete control. In the manufacture of a surprisingly large number of chemical products, stoneware has proved itself not only the best but, indeed, the only material which can be used for certain apparatus. It is, therefore, of the utmost importance that chemists should know exactly its most essential properties.

primary deposit kaolin, which is the main constituent of porcelain. The figures given below of the usual limits in the composition of the two materials show the extraordinarily great possibilities inherent in " stoneware ":—

		Hard Porcelain	Stoneware
Clay substance	(*a*) Kaolin	42 to 66 %	—
	(*b*) Clay	—	30 to 70 %
Quartz		12 to 30 %	30 to 60 %
Feldspar		17 to 27 %	5 to 25 %

In regard to " Alchemite," these possibilities have led to the complete densification of the ware so that it has become absolutely non-absorbent. What, however, is of greater importance is that articles can now be manufactured in " Alchemite " of whatever size is possible normally with ordinary stoneware.

No property of stoneware is of such decisive importance for many of the purposes of the chemical industry as its degree of water absorption. Stoneware, however slightly



Examples of Articles which can be advantageously made in "Alchemite."

One of the most important of these properties is that the ware should be as far as possible non-absorbent. In the past it has been more or less taken for granted that nothing better than from 2 per cent. to 3 per cent. absorption could be looked for in this ware. Then by improvements in the composition a ware with only from 0.5 per cent. to 2 per cent. absorption was offered. This, however, only indicated a difference in degree, and the ideal to be sought for was obviously a ware with a water absorption not of " from—to," but one with no water absorption at all. This has now been attained in a new English ware, which has been given the name of " Alchemite."*

Small objects of stoneware with a water absorption of nil have been made for a considerable time. This ware borders on hard porcelain, and indeed is just as excellent as that material for those purposes where it can be effectively used. Ware of this kind is made in a similar way to porcelain, and outwardly is distinguishable from the latter only by its colour.

The body differs frequently—not always—from hard porcelain in that secondary deposit clay is used instead of

* Made by Doulton and Co., Ltd., London.

absorbent, is not suitable where the precious metals, such as platinum, rhodium, gold and silver are used; nor is it suitable for the manufacture of highly valuable chemicals such as are rare and difficult to procure. The same objection holds good in all other cases where losses in production are particularly prejudicial. For such purposes a ware with a water absorption of nil is alone suitable. When ordinary stoneware is used by industrial chemists for the manufacture of certain salts, which in solution force their way into the smallest pores of the material, crystallisation takes place in the pores, with the result that small particles of the ware break away from the surface and even in some cases the body of the ware itself is shattered.

A ware such as "'Alchemite " with a water absorption of nil has the advantage of being completely indestructible in this respect. The manufacture of chromic acid is a case in point where a non-absorbent ware is absolutely necessary. Again, where hydrogen peroxide is used its readiness to decomposition in contact with the most varied kinds of materials is well known. Although in many instances the manufacture, transport and distribution of this chemical in stoneware vessels has been extraordinarily successful, the same results cannot invariably be relied upon. For a long time this fact

was puzzling, until it was proved that even a slight porosity of the ware so increases the extent of the inner surface that a catalytic disintegration of the hydrogen peroxide is brought about. Similar experiences could be adduced in the perborate and peroxide industries and in all processes where use is made of hydrogen peroxide or other "per" compounds for bleaching purposes. Examples of this are to be found in the textile and also the straw hat industry, etc.

In the foodstuff industries stoneware has an advantage which is not found in any other material. It is completely proof against attack of any of the materials or chemicals naturally present or artificially added in the process of manufacture. The taste, colour and the purity of the foodstuff are absolutely unaffected by any chemical reaction of the ware. This is obviously a very important factor. Yet, in spite of this undisputed advantage, and of the acknowledged superiority of stoneware, the material has not found universal use in certain branches of the foodstuff industries. One reason and one reason only exists for this, *viz.*, that the porosity of ordinary stoneware is variable, and a porosity —however slight—is undesirable.

The ease with which foodstuffs can be spoilt makes absolute hygiene in manufacture essential. If traces of the material remain behind in the pores of the ware they endanger, by their taint, or by their different flavour, the next "charge." The advantages which stoneware offers through being in itself unattackable and therefore in no way affecting the flavour, can only be guaranteed where the ware is absolutely non-absorbent. That a British ware of this kind is now available has therefore the greatest possible significance for large sections of the foodstuff industries. With this ware it is possible to preserve unimpaired the purity of the product and of its natural flavour.

Taps are among the most common plant accessories used in chemical works. In spite of occasional difficulties, the use of stoneware for their manufacture is unsurpassed. Any shortcomings which may arise now and then can in most instances be traced to slight porosity of the ware. Every difficulty of this kind is obviously removed if the taps are made of a completely non-absorbent material. In the interests of absolute reliability, therefore, the very great importance of having taps made in this ware with a water absorption of nil requires no emphasis.

It is clear that a ware with a water absorption of nil, and therefore of great density, must have an enhanced mechanical strength as compared with ordinary stoneware when used in the erection of the same kind of plant. In cases where the material has to meet not only certain chemical but also mechanical requirements, preference will therefore be given to a ware of this nature. This would apply, for example, in the case of mill linings, grinding balls and rollers.

There is no ceramic product which is completely resistant to attack by alkalies. The chemical reaction is not of great significance, but it is directly proportional to the extent of the surface coming into contact with the alkali. It is, therefore, obvious that damage to vessels made of porous stoneware must not only be very much greater than in the case of a completely dense stoneware, but this difference is so great that it is possible to speak of a relative resistance to alkalies in the case of a ware with water absorption of nil.

As already mentioned, a ware with a water absorption of nil has a considerably increased mechanical strength. It should be borne in mind, however, that there is no parallel increase in its thermal properties. "Alchemite" is not superior to ordinary stoneware in resisting changes of temperature. It is just as important for the user to be aware of this fact as to know the actual limitations of the various ceramic bodies. There is no ideal stoneware body which meets every requirement in all the various industries. Frequently one property excludes another. This very fact, however, can be regarded as a strong point in favour of stoneware, as it is possible to so vary the composition of the bodies that a ware can be produced which will meet the particular need if this is made clearly known. This presupposes that those engaged in the chemical industry will make their particular requirements clear and furnish the data necessary for the ceramist to work upon. When this is done, the ceramist can almost always evolve and supply a ware which will be suitable. "Alchemite" is but one example of this.

The next problem with which the stoneware industry is confronted is to produce a ware which will be able to resist changes of temperature by developing new special bodies Raw materials available in England possess such outstanding qualities that they furnish in themselves the basis for further improvements and developments resulting from their being appropriately prepared and combined with one another.

United States Carbon Black Trade

Statistics for 1933

THE production of carbon black in the United States in 1933 amounted to 269,325,000 lb. This was 26,625,000 lb., or 11 per cent., over the 1932 figure. Total sales, amounting to 374,644,000 lb. in 1933, were far in excess of the previous high record established in 1929 and were 43 per cent. over the 1932 figures. Of the total sales, 222,358,000 lb. (59 per cent.) represented domestic deliveries and 152,286,000 lb. (41 per cent.) represented exports. Domestic sales were 38 per cent. above those in 1932, while exports were 52 per cent. higher than in 1932. Of the total domestic deliveries, 191,358,000 lb., or 89 per cent., were consigned to rubber companies. This compares with 81 per cent. in 1932, showing that the rubber industry is more than maintaining its place as a consumer of carbon black. Sales to ink companies showed a slight increase in quantity, but amounted to only 8 per cent. of the total domestic sales compared with 11 per cent. in 1932. Sales to paint companies decreased slightly, but sales for miscellaneous purposes increased 21 per cent.

In general, all foreign customers increased their purchases of carbon black in 1933, in some cases the gains amounting to more than 100 per cent. The United Kingdom, France and Germany, in the order named, continued to be the chief customers. December was easily the leading month for exports as the foreign buyers anticipated the higher prices which became effective early in 1934.

The carbon black industry in the United States has moved steadily westward for a number of years, but the centre of production took a step eastward in 1933 when Louisiana showed the largest increase of any of the major producing districts. Although the Texas Panhandle increased production only 7 per cent. over 1932, it produced 190,356,000 lb., or 71 per cent. of the total output for 1933. The average value of carbon black at the plants, which has declined steadily since 1928, showed a slight gain in 1933, being 2.77 cents per lb., compared with 2.75 cents in 1932. The total value at the plants of carbon black produced in 1933 was $7,449,000. This compares with $6,664,000 in 1932. The average yield of carbon black remained unchanged in 1933, being 1.44 lb. per thousand cubic feet of natural gas burned. Carbon black producers reported a consumption of 186,781,000,000 cubic feet of natural gas in 1933; this was equivalent to about 12 per cent. of the total consumption of natural gas in that year.

IT is reported that a chamber for the fumigation of imported vegetable products has been erected at Havre and that similar installations are to be made in Marseilles, Bordeaux, and Dunkirk. The Bordeaux plant, which was scheduled for completion this year, will contain two autoclaves with capacities of 30 and 75 cubic metres respectively. Hydrocyanic acid gas will be used for seeds, grains and plants, and tests will be made with this gas on lots of fresh fruits and vegetables.

Fire Protection in Chemical Factories

By J. H. WEST, M.I.Chem.E.

PROTECTION against fire in chemical and allied factories is even more important than elsewhere because many of the products give rise to fires which are difficult to deal with and are not infrequently accompanied by risk of explosions.

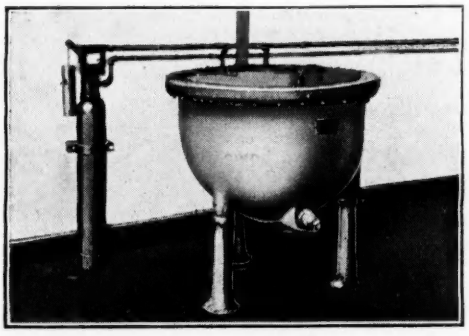


FIG. 1.—Pyrene Automatic Carbon Dioxide Fire Unit fitted to a Varnish Vat. Should the liquid become ignited, gas is rapidly discharged into the vat, thus creating an atmosphere in which fire cannot exist.

The writer would strongly urge the desirability, if not necessity, of consultation and collaboration between the factory management and its insurance company on the one hand, and the chief officer of the local fire brigade on the other, in getting out and putting into practice any comprehensive scheme of fire protection. Many factories go ahead with their own schemes without taking this precaution and it is only after a fire has occurred that they discover where they have gone wrong. The fire insurance company is always willing to send an expert who can not only give valuable advice regarding the scheme in general and put forward suggestions for dealing with special risks, but who will draw up a schedule showing the minimum equipment which will entitle the factory to a reduction of premium. As a rule two schedules are provided, a smaller one carrying a premium reduction of 10 per cent., and a larger one corresponding to a reduction of 15 per cent. or more. Where the fire risk is considerable and the premium is correspondingly high these concessions are well worth securing. With regard to the local fire brigade, it saves the brigade waste of valuable time in getting to work if the officers have been over the site of the factory and know exactly where they can obtain supplies of water for their engines, and just where the engines can be placed to deal with a fire in any given building. There is also the question of interchangeability of hydrant fittings as between the factory and the brigade. Factories in large cities with first-class brigades are inclined to depend almost entirely upon the brigade and cut down their own equipment to a minimum, whilst factories in country districts are more inclined to depend upon their own resources, but in either case it is well worth while to have the local fire officers along and go into ways and means *before* a fire ocurrs.

Fire-fighting appliances may conveniently be classified as follows:—(1) Appliances kept in process and other buildings; (2) fire hoses supplied from hydrants on an external fire main, or on the ordinary factory mains if the pressure is sufficient; and (3) centralised appliances.

The fundamental principle in combatting fire is to deal with an outbreak promptly and before it has reached unmanageable proportions, hence the importance of having adequate hand appliances within easy reach at all points. Fire buckets filled with water or sand are cheap to buy, and, provided they are kept filled and not used for other purposes, are often effective in quenching small fires. Chemical extinguishers are useful for small fires which canot be conveniently got at with a bucket. There are many types of these, some using the soda-acid principle, with or without foam-producing ingredients; others using carbon tetrachloride; and others again liquid CO_2. Where these are used particularly in positions where there is likely to be trouble from corrosion, they should be periodically tested to make sure that they are in working order. The small cost of a refill is well worth the certainty of their working when wanted. The small bore (⅜ in. to 1 in.) rubber hoses usually to be found in chemical factories for washing-down purposes are also useful in dealing with small fires, and the insurance companies will give credit for these, if of adequate length and number, in granting premium reductions. As a general rule it

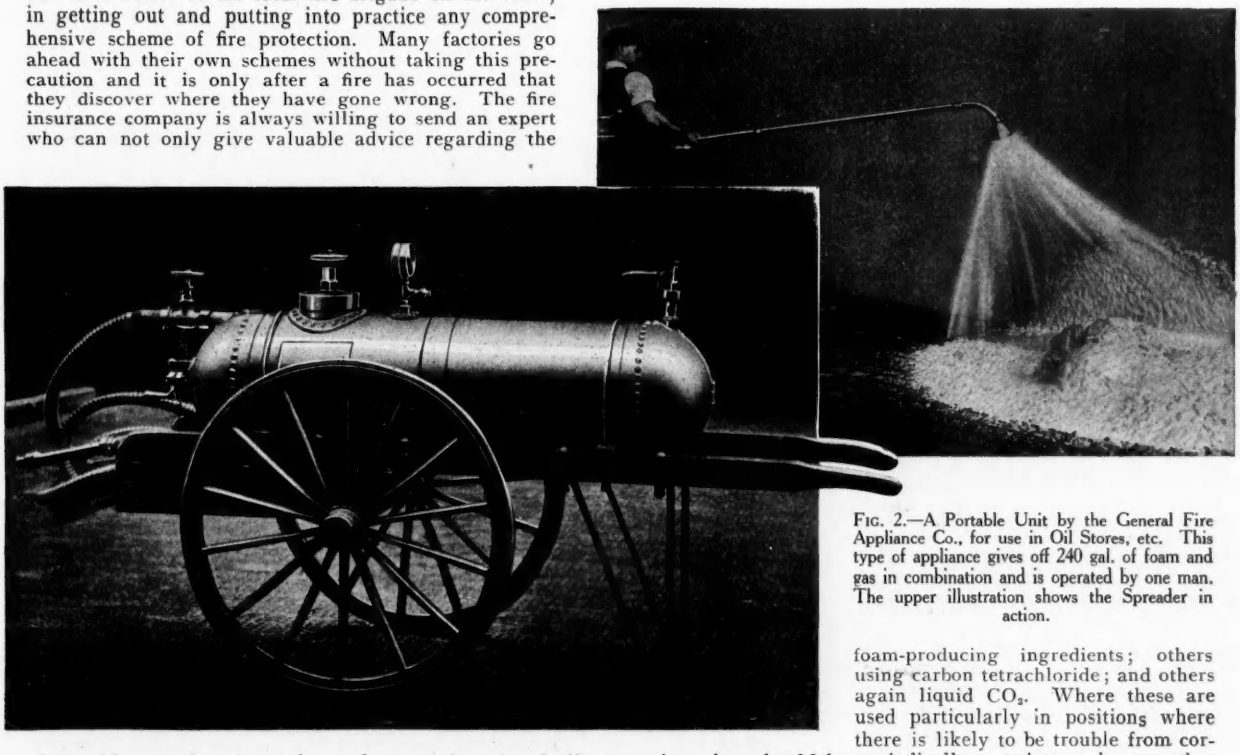


FIG. 2.—A Portable Unit by the General Fire Appliance Co., for use in Oil Stores, etc. This type of appliance gives off 240 gal. of foam and gas in combination and is operated by one man. The upper illustration shows the Spreader in action.

is not worth while having proper fire hydrants and fire hose in process buildings of the usual type, though an exception to this rule might be made in the case of large multi-storey buildings in the fine chemicals branch, and also in office

FIG. 3.—Foam Generator made by the Pyrene Co., Ltd. The Foam is produced from a Powder contained in a Cartridge. Used as a single Unit, one charge will produce over 300 gal. of Foam.

blocks. Automatic sprinklers come under the first classification, and these are useful in packing departments where there are quantities of inflammable material about, but in view of their expense they are not often to be found in chemical factories. This refers to built-in water sprinklers. There are, however, now available small automatic units operated either by a fusible link or by a temperature-controlled electric contact which can be applied to a single vessel or a confined space like a paint or lacquer spraying booth. Fig. 1 shows a CO_2 unit of this kind by the Pyrene Co. applied to a varnish vat. Similar units using foam and chemical media are available.

Fire Mains and Hydrants

Except on congested sites where it is not possible, the factory fire main should be run underground well away from buildings. It is far better to have a fire main separate from the ordinary factory supply main, with proper arrangements for maintaining an adequate pressure. Hydrants should preferably be of the type controlled by a ball valve actuated by a screw-down rod in the stand-pipe. Stand-pipes and hose couplings should be interchangeable with those of the local fire brigade. This is an important feature which is often neglected. Beside each hydrant should be a box or cupboard painted red and containing stand-pipe, two lengths of hose and two branch pipes or jets. Additional lengths of hose can be kept in the stores. Hydrants and hose boxes are much better at least 30 to 40 feet away from buildings wherever this is possible, otherwise they may quickly become inaccessible in case of fire.

It is important that proper provision be made for the supply of water to the brigade fire engines in factories where there are no public street hydrants close by. If the engines have to be supplied from public hydrants some distance away much time is lost in running out and coupling up long lengths of hose. This question should be gone into with the brigade officer. A small supply, about ½ in. bore will be required for the radiator of the fire engine. If inflammable liquids have to be dealt with in connection with which water would do more harm than good, the buildings in which these are kept should be pointed out to the fire officers.

Special Risks

In factories where highly inflammable substances are made or used special equipment will be required. Among such substances are alcohols, mineral spirits, oils, varnishes, fats, waxes, turpentine, camphor, rubber, celluloid, acetone, glacial acetic acid, and so forth. Fires of these materials can only be dealt with by foam or CO_2, or on a small scale by carbon tetrachloride. Fig. 3 illustrates a foam generator by the Pyrene Co., in which the foam is produced from a powder contained in a cartridge by the action of water. The generator is coupled up in a line of hose, and, if two generators are coupled in parallel by means of Y pipes on the inlets and outlets, one can be recharged while the other is working, thus providing a continuous supply of foam as long as there are cartridges of powder available.

Fig. 2 shows a portable unit by the General Fire Appliance Co. in which foam is produced by a mixture of liquids, one of the ingredients being methyl bromide, to increase the fire-quenching properties of the foam. Fig. 4 shows a battery of CO_2 cylinders by the Walter Kidde Co provided with special gang release gear to discharge the gas from all the cylinders simultaneously. The control is automatic, and on the temperature rising to a certain degree at the control point, which may be at any distance from the battery of cylinders, the gas is discharged.

It is important that the factory staff should know exactly what to do in case of fire breaking out. One or two persons on each shift in each department should be trained in the use of the appliances provided, and should be made responsible for seeing that these are always in good working order. Written instructions should be posted up detailing the duties

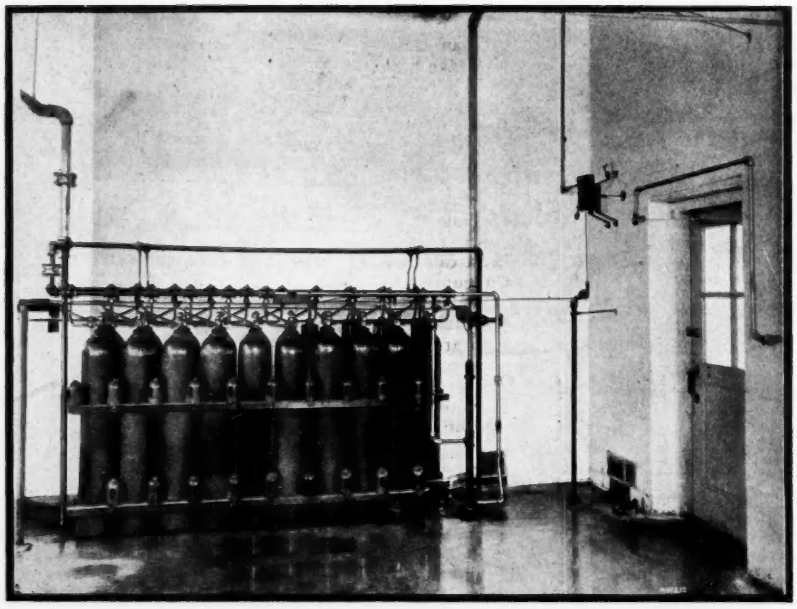


FIG. 4.—Battery of Carbon Dioxide Cylinders by the Walter Kidde Co., Ltd., for Automatic Operation, showing the special Gang Release Gear to the right of the Cylinders.

of the staff in case of fire, particularly with regard to shutting down the process plant and getting the workpeople out of any danger area where there is likelihood of an explosion. If the fire occurs out of office hours the night superintendent or the senior shift chemist should immediately send for the works manager and the works engineer, as well as summoning the fire brigade.

In some cases a city or town brigade will not take its engines to a fire outside the city or town boundaries unless and until an undertaking is given by a responsible official of the company on whose premises the fire has broken out to pay the charges made by the brigade for their services. This little matter should, of course, always be settled beforehand. Apart from fire-fighting appliances, the spread of fire in large buildings can be minimised by the provision of fire-proof doors between different sections. The insurance companies often ask for these in connection with their requirements for reduction of premiums.

Prevention is better than cure, and the best form of fire protection is to eliminate as far as possible all causes of fire. The electric wiring is usually blamed when no other cause for a fire can be found, though a properly carried out system of wiring should be absolutely safe in this respect. In chemical factories, however, the wiring often has to put up with a rough time from corrosion and fumes, and it must in such cases be specially designed to resist these effects, and the same remarks apply to fittings. Oily rags or cotton waste lying about in hot situations are a source of danger. Woodwork should always be kept away from flues, stove pipes and steam pipes. With regard to the latter it is not generally realised that, given a confined space and contact with easily inflammable material, fire may start at an extraordinarily low temperature. The writer knows of a case in which a pipe, carrying saturated steam at 40 lb. pressure (temperature 142° C. or 287° F.) passing through the double wall of a wooden building, caused a fire. The confined space between the inner and outer boarding and some shavings left there by the builders provided the necessary conditions. Smoking and the carrying of naked lights in danger areas must, of course, be not only prohibited but effectively prevented.

A point of importance with regard to highly inflammable liquids is that means should be taken to prevent the liquid spreading in the event of a container bursting or a large valve breaking. In Germany a pit has to be provided under such containers large enough to receive the whole contents of the container.

Visitors' Day at the Fuel Research Station

A Survey of Current Investigations

THREE hundred guests accepted the invitation of the chairman of the Fuel Research Board (Sir Harold Hartley, F.R.S.) and the Director of Fuel Research (Dr. F. S. Sinnatt) to inspect the Fuel Research Station at East Greenwich, on Monday. This was the first time such a large number of visitors had been received; they included representatives of all fuel interests, including the larger industrial users of coal and many distinguished scientists.

Although the work is divided into separate branches, they are interrelated, and the results obtained in one branch have definite repercussions on the other branches. A first essential is a knowledge of the properties of the coal available. One of the exhibits in the laboratories is devoted to the complete examination of a coal seam as it is carried out in the nine laboratories situated in the principal coal areas throughout the country. The coal survey is an integral part of the work being carried out at the Fuel Research Station.

Chemical Constitution of Coal

The chemical and physical constitution of coal and the nature of the compounds of which it consists is being investigated by several methods, including the action of solvents and the examination of oxidation products. More certain knowledge of the constitution and differences of the various species of coal is necessary as a guide to its most economic treatment in industry and as a possible starting point of fresh developments. Investigations on the combustion and carbonisation of coal in powder form are also in progress.

In the laboratories the question of the production of suspensions of coal in oil and the factors affecting their stability during storage are receiving attention. Important work has been done recently on the carbonisation of coal in horizontal retorts. By a simple arrangement for introducing steam into the retorts it has been found possible to increase the yield of gas made by 7 to 10 therms per ton of coal carbonised. This method has been tried in three large gasworks, which report similar general results to those found at the station.

Another line of work related to the carbonisation of coal is concerned with the treatment of the tars. The general purpose is to produce from tar, products which will find a ready market in industry. The station is, therefore, engaged on an investigation of the properties of the tars produced from coal at different temperatures with particular reference to (1) its suitability for hydrogenation for the production of motor spirit or lubricating oil, and (2) for cracking to produce similar products. Already it has been found that tars produced by carbonisation below a certain temperature are more amenable to hydrogenation than tars produced at higher temperatures, but it is considered that with improvements in the technique for the hydrogenation of tar the range of carbonisation temperatures can be extended.

A further programme on the hydrogenation of tar and coal is concerned with the production of lubricating oil, and specimens were shown of the lubricating oil bases produced by the treatment of light spirits with condensing agents, and fractions obtained by the hydrogenation of tar and of coal. A plant dealing with 1 cwt. of low temperature tar a day has been developed, and the chief difficulties encountered in working a semi-commercial plant to deal with two tons a day are being solved. The design of the converter in use at the station has been so modified that while the catalyst chamber operates at a temperature of 480° C. the walls of the converter, which withstand the reaction pressure of 200 atmospheres or more, are maintained at temperatures not exceeding about 100° C.

Cleaning of Coal

In the general development of the use of coal in industry importance is attached to the production of coal as free as possible from extraneous dirt, and this problem is constantly being encountered in the course of the survey of the national coal resources. Among the problems still unsolved is the purification of fine coal and the recovery of the fine coal in suspension in the water used for coal washing. These two problems are among those being studied in the coal washing section, and the Elmore plant, which treats coal smaller than $\frac{1}{8}$ in. was seen in operation yielding a froth of clean coal produced under vacuum which, when exposed to the atmosphere, drains readily. A British Baum unit capable of treating two tons of coal an hour represents the washery plant used to the greatest extent in this country. An H. H. concentrating table capable of treating 6-10 tons an hour was demonstrated, capable of treating efficiently special sizes and particularly small sizes.

The process of precipitating fine coal from suspension in water by means of chemical reagents, which was discovered by an officer of the station, and an ingenious plant for the precipitation of coal in suspension by mechanical means, were also exhibited. A method of dry cleaning coal, based on a novel design, is being developed. This will allow for the treatment of all coal passing a $\frac{3}{4}$ in. screen without further separation into sizes.

The staff employed at the Fuel Research Station amounts to 213. Of these 58 are scientific and technical.

The National Physical Laboratory

Annual Inspection at Teddington

THE annual inspection of the National Physical Laboratory at Teddington took place on Tuesday afternoon, when more than 2,500 visitors, including the presidents and other officials of a number of chemical organisations, attended. They were welcomed by Sir Frederick Gowland Hopkins, president of the Royal Society and chairman of the general board, and after inspecting the many new branches of work being carried out at the laboratory they were entertained to tea.

The increasing use of higher working temperatures in power and chemical plant necessitates knowledge of the resistance of metals to stress at high temperatures. Considerable research is being carried out at the laboratory in the examination of the creep of metals under static tensile loads, and also under bending stress, and combined torsion and tension stresses. An investigation of the continuous contraction with time (creep recovery) of materials, resulting from partial or complete removal of tensile stress after a period of creep under stress, is being made. The equipment available includes machines capable of measuring rates of creep of less than one-millionth of an inch per inch per day on specimens maintained at temperatures up to 800° C.

Lubrication Research

The measurements of the aspect angle and eccentricity of a bearing have yielded results which are in agreement with the theory of fluid lubrication for observations over short ranges of temperature, but show discrepancies at temperatures outside this range. The explanation of these discrepancies has been sought by examination of the distortion of the bushes produced by load and heat. Some of the results obtained and the apparatus used were exhibited.

Apparatus was also shown which has been designed to measure the roughness of the journal surfaces and is applicable to the measurement of surface roughness generally. It appears from tests made upon stainless steel and mild steel journals under conditions such that fluid friction should be maintained, that the friction is dependent upon the surface condition of the journal. With surfaces of similar roughness there does not appear to be any difference between the frictional resistance of a stainless steel and a mild steel journal. The research into the effect of oxidation upon the friction and seizing temperature has been continued, and there is evidence to show that the low friction and high seizing temperature of an oxidised oil is due to improvement in the surface condition of the bush caused by continued running of the bearing.

The friction of an oscillating bearing lubricated with a heavy oil has been obtained up to a frequency of 1,000 cycles per minute, and it is found that at low temperatures the friction increases with the speed of oscillation, while at high temperatures the friction increases after a certain frequency of oscillation is exceeded. This indicates that the friction is dependent on the viscosity of the oil, and not entirely on the constitution of the boundary layer. Tests made with B.P. paraffin, with and without admixtures of palmitic acid, give results similar in some respects to Hardy's boundary friction observations. Palmitic acid alone, which gives zero friction in Hardy's experiments (in which the speed of rubbing approached zero), gives a coefficient of friction of about 0.1 when the journal is oscillating at 1 cycle per minute.

Metallurgy Department

In order to obtain cooling curves of metals with great accuracy, the specimen examined in the gradient furnace and thermal curve apparatus is caused to pass through a uniform temperature gradient. In the furnace, which was shown, the specimen is stationary, and the furnace is raised at a uniform rate by a geared motor. A rotating apparatus is used for taking thermal curves of alloys which, if allowed to remain at rest, would undergo segregation. The apparatus for the examination of thin surface films by the diffraction of beams of electrons has been modified in order to examine the films formed by oxidation on the surface of molten metals. The tube is horizontal instead of vertical, and a furnace is provided in the evacuated space for the purpose of melting a bead of metal. In the determination of oxygen in steel by vacuum extraction the steel is melted in a graphite crucible by means of an induced current of 10,000 cycles frequency supplied by a rotary generator. The gases evolved, which contain the whole of the oxygen originally present in the steel, now in the form of oxides of carbon, are pumped off and analysed.

Proposals have been made to establish the length of a wave of light as the basis of definition of the fundamental units of length. An important part of the procedure of establishment consists of measurements of the present fundamental standard of length, the Imperial standard yard and the international prototype metre, in terms of light waves. This work has recently been completed, with the aid of the wavelength comparator designed and made at the laboratory, using waves of the red ray of cadmium. The accuracy obtained in the optical measurements of length was between one and two parts in a hundred million, thereby reducing the uncertainty of measurement of a yard length to a quantity smaller than a millionth part of an inch. Other advantages to be obtained by the proposed new basis of definition are the avoidance of the risks of variation and damage associated with the present material standards, which could be verified at any time in terms of a natural, invariable and easily reproducible unit of length.

Heat Transmission

Work has been in progress for some time at the laboratory (for the Food Investigation Board) on the problem of heat transfer between metal pipes and a stream of air passing over them. This principle is used in many industrial processes, and numerous investigators have determined overall heat transmission coefficients for particular sizes of pipe and ranges of air velocity. At the Laboratory the problem has been restricted to that of the transfer at the outer surface of the pipe, and the results for single pipes have been correlated by the principle of similitude. When the pipes are arranged in batteries, the possible geometrical configurations are many. Two of the forms of common use in refrigeration have been studied, and, besides giving data appropriate to the particular configuration studied, they have shown the great importance of eddy motion both as caused by the battery itself, and also when artificially introduced. The use of a frame of wooden laths to make the air turbulent before it impinged on the pipes could increase the heat transfer by nearly 100 per cent. Similar observations on pipes colder than 0° C. showed that the laws deduced for hot pipes would still hold, provided the diameter measured and the temperature taken for the outside of the pipe refer to the outside of the snow or ice deposit which forms in such cases.

Measurement of Colour

In the optics division a preliminary model is shown of an instrument which can determine the colour of a specimen without any colour-matching by the eye of an observer. The eye is replaced by a photo-electric cell, in which an electric current is set up by light falling on the cell. In the system of colour measurement developed at the laboratory—and now adopted internationally—any colour is expressed by three numbers. These numbers may be regarded, in non-technical terms, as measures of the proportion of redness, greenness and blueness which contribute to the actual appearance of the colour. In the new instrument, the photo-electric cell "sees" the colour under test through three coloured screens in succession, and the current which it generates is noted in each case. The relative magnitudes of these currents give the three numbers which measure the colour on the international system. The new instrument is specially useful for rapid determinations of the comparative values of similar colours.

British Non-Ferrous Metals Research Association

Progress of Investigations

ACCORDING to its annual report for the year 1933, the British Non-Ferrous Metals Research Association is now building up a team of research workers who will specialise in different subjects and form a permanent staff, capable of carrying on existing research and dealing with new researches as they arise, instead of employing investigators specially engaged for a particular research. In accordance with this policy the laboratory work of the Condenser Tube Corrosion Research was transferred from the Royal School of Mines in October, 1933, and the Association now has a strong section in its own laboratories able to deal with corrosion problems as they arise. It will be remembered that this research, the Institute of Metals Corrosion Research, was started as long ago as 1910 with Dr. G. D. Bengough as the investigator, working in Liverpool, and that the Association, on being invited to do so, took over the control in March, 1930. For seventeen years research was carried on continuously in the metallurgical laboratories at the Royal School of Mines, and corrosion research in this country owes a great deal to the authorities of the Imperial College, and to Sir Harold Carpenter especially, for the accommodation provided and for the help and stimulation of the work.

Aluminium Research

Arrangements were also made in 1933 for the transfer of the Aluminium Castings Research from Birmingham University to the Association's laboratories in London. The results of the investigations carried out in Birmingham by Dr. I. G. Slater working with Professor Hanson have not only thrown a great deal of light on the subject of gases in aluminium and its alloys generally but have led to the provision of a simple and inexpensive treatment which is proving a very effective degassing process. By the end of the year the work had reached a stage of completion at which the research could conveniently be moved, and accordingly the research staff at headquarters is still further strengthened by the presence of Dr. Slater.

Of the new researches which are being planned mention may be made of an important new research under the general title of the effect of macrostructure on working properties of brass and other non-ferrous metals and alloys which will be commenced in the coming year, and carried out partly at the Research Department, Woolwich, and partly at headquarters. A research on the corrosion of copper (copper water service pipes, etc.) will be undertaken as a resumption and extension of the previous research on copper water service pipes. The question of bismuth in copper has received a considerable amount of attention during the year with regard to its determination by chemical and by spectrographic methods, and also with regard to its removal in fire-refining. The subject of the removal of bismuth has assumed sufficient importance to warrant the planning of a systematic exploratory investigation of the problem at all stages in the extracting and refining of copper.

Lack of Equipment

In the previous annual report reference was made to the want of additional equipment for which funds were not available, and a number of items were mentioned for which there was particular need. It is to be regretted that the words then used might be repeated in their entirety in the present report. Particularly is this the case with regard to the lack of forging and rolling equipment. While the generous offers made by member firms to place facilities in their works at the disposal of investigators are fully appreciated, and have where possible been gratefully accepted, the fact that the laboratories possess no means of rolling or power forging metal on however small or "experimental" a scale must be regarded as a serious shortcoming.

An investigation into possible segregation in works ingots of copper has been in progress at the National Physical Laboratory during the year. Ingots prepared in the works of members have been sectioned and examined. Rolling tests and mechanical tests on duplicate ingots have also been made. In this work particular attention has been paid to the possibility of segregation of bismuth, and in this connection a special method has been developed for the chemical analysis of small samples of copper containing very low percentages of bismuth. A considerable amount of attention has been given, by the Development Department, to the practical aspects of this research, and a report has been prepared by Mr. G. L. Bailey reviewing the information obtained from industry in relation to the results of the research.

It is realised on all sides that this research has provided an enormous amount of reliable, authoritative data. It is, however, the general opinion that although much further research on this wide and important subject is still needed, the stage has been reached when time should be given for the industry to assimilate and utilise the results. It has accordingly been decided that the present research shall be terminated in the year 1934, the outstanding investigations rounded off, and a summary report on the work of the research as a whole prepared.

The Effects of Tarnish

The programme of investigation to determine the relative resistance to atmospheric tarnishing of a wide range of metals and alloys has now been completed, and a final summary report has been prepared. The effects of tarnish on the polished surfaces of the various materials tested have been expressed on a quantitative basis using a special method of measuring reflection properties. This method has been developed with the kind co-operation of the Research Laboratories of the General Electric Co., Ltd., and the apparatus is being kept available for possible future work. The scope of the research also covered a determination of the effects of various types of methods of removing tarnish, together with the effects of cleaning treatment upon the subsequent rate of tarnishing. The termination of the present investigation completes thirteen years of continuous research by the Association on the general subject of atmospheric corrosion, and a report is in preparation summarising the results of the work as a whole.

In the course of the main research on the properties of lead (concerned primarily with the prevention of cracking in lead cable sheathing) which reached its first objective with the introduction of the B.N.F. ternary lead alloys, a number of related problems were seen to require solution. Work during 1933 at the Research Department, Woolwich, has been devoted to completing the investigation of these subjects, for example, lead-barium alloys, the mechanical properties of binary alloys of lead with nickel, lithium, gallium and other metals, age-hardening, the creep of lead alloys, and segregation in lead-antimony alloys. Reports on these investigations will be available in the near future and will mark the completion of the present research.

Use of the Spectrograph

Metallurgical applications of the spectrograph have continued to receive attention throughout. A final report on the determination of impurities in lead and its alloys has been made available, together with supplementary reports dealing with sodium and tellurium in lead. The standardised methods have been used during the year for the analysis of a large number of samples of lead. "Metallurgical Analysis by the Spectrograph" by D. M. Smith, which was published in September, 1933, summarised the work of the research and included all the results up to that date with regard to the estimation of minor constituents in zinc, tin, lead and copper. Work on the estimation of impurities in aluminium is approaching the final report stage, and progress has been made with further work on the estimation of bismuth in copper. Evidence of increasing interest in the Association's work on this subject is afforded by the number of technical inquiries received and answered, and by requests from members for advice with regard to suitable equipment.

The Association's arrangements with the Research Department, Woolwich, whereby various aspects of the electrodeposition work carried out for the Government services are developed along lines likely to be of special interest to members, have continued but, owing to staff changes at Woolwich, were in suspension for part of the year. Reports on the determination and significance of porosity and tests of thickness of cadmium coatings on steel have been received, and work has been in progress on the adhesion of nickel coatings to aluminium and to steel. The various Woolwich investigations on the causes, detection, measurement and prevention of porosity in electrodeposited coatings are resulting in substantial and useful increase of knowledge of this important aspect of electroplating.

Gases in Aluminium

Research on aluminium castings has defined the fundamental principles underlying gas-metal equilibria and the absorption and escape of gases from aluminium alloy melts. Based on the results of the laboratory investigations, methods have been evolved for eliminating gases from aluminium alloys, and the conclusion appears to be justified that an effective, yet simple and practical process is now available. Provisional patent protection has been obtained for the method, and large-scale tests on melts up to 600 lb. have been made with the process in members' foundries.

Galvanising research has been carried on throughout the year, and, although it has suffered somewhat from changes in personnel, due to staff resignations, good progress has been made. Mr. E. J. Daniels, who had been in charge of the work since the commencement of the research, left the Association in the summer of 1933 to take up another appointment. A report by Mr. Daniels, summarising the work of the research while he was the investigator and reviewing its position, has been made available, and he has also prepared a further report on the subject of galvanising generally and the results of the research, which has also been made available.

In accordance with the arrangements made with the International Tin Research and Development Council, investigations on tin coatings have continued actively at the Research Department, Woolwich. Work on the electrodeposition of tin has shown that sound tin deposits of any desired thickness can be produced; coatings 0.0005 in. or more in thickness on steel have been found to be substantially free from pores. A process has been developed for the elimination of porosity in hot-dipped tin coatings on steel. Further work is being directed towards improvement in the quality of tin-plate, and an experimental tinning machine has been installed for this purpose.

Alloys for High Temperature Work

In regard to alloys for high temperature service the work aiming at the development of alloys based on 80/20 cupro-nickel, with improved properties for service at elevated temperatures, has been continued by the study of the effect of addition of various elements. The study of the properties of cupro-nickels containing silicon and manganese has given promising results, and attention has also been devoted to the heat treatment of various cupro-nickels containing aluminium. Small percentages of tungsten, molybdenum, vanadium, tantalum and beryllium have been introduced in 80/20 cupro-nickel by melting *in vacuo* or in purified hydrogen, and the properties of the alloys as produced have been examined.

Zinc coatings have been investigated throughout the year by Mr. S. C. Britton, working in the University Chemical Laboratory, Cambridge, under Dr. U. R. Evans. A new test for zinc coatings on wire has been devised which promises to be of value, and it is being developed and standardised for use in routine testing. Other work has enabled the conditions of severe corrosion attack of galvanised hot-water tanks to be largely defined, and is being continued to provide information on the relative corrosiveness of various types of water and the part played by different constituents of domestic water supplies. This research has not yet succeeded in providing a simple and entirely effective remedy for the trouble, but even if such a measure of success is not attained, the light already thrown on the causes of corrosion of hot water tanks should be of considerable practical value.

East End Hostels Association

Tributes to the John Benn Hostel

ELOQUENT tributes to the work of the John Benn Hostel for homeless boys in Stepney were paid by the Master of Marlborough, Mr. John Drinkwater, Lord Snell, and the Rev. Dr. H. R. L. Sheppard at the eighth annual banquet of the East End Hostels Association held in the historic Stationers' Hall, London, on June 21. Mr. John Walter presided. At the close of the banquet Mr. A. Townshend, Warden of the Hostel, was able to announce that promises of donations to the funds amounting to £1,091 had been received. The chairman read the following message from the Prince of Wales: "With pleasant recollections of dining with the boys at the Hostel a few years ago, I send my best wishes to all friends and supporters present at to-night's dinner of the East End Hostels Association. I am only sorry that as Master of the Stationers' Company I cannot be with you to-night, but I hope you will have a pleasant and successful evening."

Mr. G. C. TURNER, master of Marlborough, proposed the toast of "The London Boy." The great work which the John Benn Hostel was performing, he said, was to give the London boy something in the nature of a home. It could not be precisely home but it could provide the real essentials of a home in a boy's life and it assured him that there were people who cared what he did and what he became.

Mr. JOHN DRINKWATER, who replied, said the East End Hostels were endeavouring to do something for the small and lonely boys of London who had not been blessed at their birth with the materially good things of life. "I believe," Mr. Drinkwater asserted, "that when the social history of this age comes to be written, the most characteristic feature of our activity will prove to be that we have, more than any preceding generation, begun to think about the welfare of those people who are not materially fortunate in their origins. It is not a thing we need pride ourselves about very much; it is just one of those incidents of social history which are common to every age in some shape or other."

Encouragement in Place of Compulsion

Mr. JOHN WALTER submitted the toast of the John Benn Hostel. He said he had been deeply impressed when visiting Stepney by the wonderful work that was being done by those responsible for the John Benn Hostel. A serious effort was being exerted there to supply the needs, bodily as well as mental, of the boys who were alone in London striving to make a start in life—many of them learning the meaning of the word home for the first time. In the John Benn Hostel he found that encouragement took the place of compulsion. Discipline, of course, there had to be, but it was a kindly and intelligent discipline and the boys were urged to live their lives individually, though they understood the meaning of loyal co-operation.

Lord SNELL, chairman of the London County Council, who supported the toast, said the John Benn Hostel had greater scope than many boys' homes. It placed no coercive powers upon the boys to become unnaturally pious, but attempted to develop the personality of a lad and to make him feel he, too, had something to give and the ability to create.

The Rev. Dr. H. R. L. SHEPPARD, who associated himself with the toast, spoke in warm terms of appreciation of the Warden of the Hostel. Coupling with the toast the name of Sir Ernest Benn, Dr. Sheppard said there was only one hostel at the moment, but there was room for many more. He did not know how money could be better spent than in providing something as informal and valuable as the John Benn Hostel.

Sir ERNEST BENN, in his response, referred to the many distinguished figures who had occupied the chair at the hostel's banquet and welcomed Mr. John Walter to that position. He extended an invitation to those who had not visited the Hostel to go there and assured them of an interesting and delightful experience.

Mr. ERIC MILLER, chairman of the council of the Hostels Association, proposed the toast of the Worshipful Company of Stationers and Newspaper Makers.

Lord ILIFFE replied.

Lord MESTON proposed the toast of the chairman and brief response was made by Mr. JOHN WALTER.

Carbon Black Developments

Rapid Increase in Consumption

RECENT developments in carbon black technology were discussed in the course of a lecture delivered in London on Monday, by Mr. W. B. Wiegand, technical director of the Binney and Smith Company, New York. Some of these developments were illustrated by a cinematograph film. Discussing the rapid increase in the rate of consumption of carbon black, Mr. Wiegand said the increase had been resumed after having been arrested temporarily by the recent depression, and in 1933 the consumption reached the enormous total of 360,000,000 lb.

In the evolution of the carbon black industry there were three distinct eras. In the first place, there was the era of colour, extending up to 1914; then there followed the era of rubber reinforcement, from 1914 to 1927; and thirdly, the era of combined colour and reinforcement of paint and lacquer films. The third era had been made possible by the discovery of new grades of carbon and of an entirely new technique in dispersion. The distinctions between true carbon black and lamp black were reviewed, and reference was made to the importance of impingement, this, rather than the raw material used, being the critical factor.

Fine Sub-Division

The extreme fineness of sub-division of carbon black was also emphasised, it being pointed out that 1 lb. of the material developed a superficial area equivalent to 15 acres. Reviewing some of the results of such fineness, Mr. Wiegand said that carbon black should be regarded more as the analogue of calcium chloride than of an inert material in so far as avidity towards moisture was concerned. He stressed the advisability of keeping high-quality colour blacks in the driest possible locations, and of ensuring that the moisture content did not exceed 3 per cent. Adsorption was also dealt with, and the typical adsorption isotherms exhibited. The applications of adsorption in drying behaviour were emphasised, and he pointed out that complete information on this subject is now available in respect of the various grades of carbon furnished by the Binney and Smith Co.

Colour was referred to as being a function, not of purity of composition, but rather of fineness of sub-division. Concentration was another important function. Colour and tinctorial strength were shown to be not entirely parallel. Again, attention was drawn to the all-important rôle played by the vehicle, and the importance of the presence in sufficient amount (approximately 10 per cent. or more) of organic acidity. The evolution of milling technique was illustrated by a table indicating the gradual increase in concentration of black for base grinds as the mill equipment was developed from the flint pebble mill to the most modern types of single or multiple roller mills.

Oil Absorption and Colour Intensity

Until recently, oil absorption had been related directly to colour intensity, and this circumstance had proved the obstacle to the further improvement of the quality of black, until new process blacks were evolved in the Binney and Smith Co.'s, New York, research laboratories. Reference was made to the improved surface character of these new process blacks, and Mr. Wiegand ascribed their greater affinity for vehicles to an altered oxygen structure, which had the effect of making possible the distribution of monomolecular layers of suitable polar dispersion media. With this new structure the use of dispersing agents was deprecated as being inimical to the properties of the vehicle when used in percentages sufficient to influence dispersion favourably. With the new process high-intensity colour blacks it was possible to obtain lower oil absorption, greater ease of dispersion, higher gloss in the resultant film and lower grinding costs, provided that the proper black was selected in relation to the colloid chemical properties of the dispersion medium, whether this medium be linseed oil, a synthetic resin or a lacquer.

A second development made in the company's laboratories was the evolution of an entirely new technique of dispersion, by which the development of the inherent blackness or intensity was for the first time made possible. By the new dispersion technique the black and the vehicle were premilled or associated in a perfect colloidal matrix which required only solution to produce a finished lacquer. The name " Coblac " had been given to this new product.

A still more recent development had been the increase in the charge of carbon black, resulting in a product known as " Globlac," and it was interesting to note that in "Globlac " reinforcement dosages which over a period of decades had revolutionised the performance of the automobile tyre were now available to effect a similar revolution in the art of lacquer and paint protective films. It was in "Globlac" that he considered the third era (the era of combined colour and reinforcement) had for the first time been reached. Whereas in the rubber industry carbon black had been used in spite of its colour and because of its reinforcing qualities, in the paint and lacquer industry it would play both rôles at the same time.

Industrial Water Supplies

Information on Softening Practice

A NEW water treatment booklet has been published by Imperial Chemical Industries Ltd. This booklet sets a new standard in the production of works of this type on account of its design and treatment. At the same time it not only summarises the existing knowledge on water treatment, but also contains much new matter relating to the practical application and control of the lime-soda process of water softening—a field in which the Alkali Group of I.C.I. possess unique experience.

After classifying natural waters on the basis of the various types of impurity which they may contain, and discussing their effects in the principal consuming industries, the book deals more particularly with the causes and effects of hardness in water, and outlines methods for its quantitative measurement and removal. Control measurements are discussed which are essential for the economical working of precipitation methods of softening. Prominence is naturally given to the lime-soda softening process, which is fully dealt with from such standpoints as its fundamental chemistry, the design of modern plants for its operation, and its modifications to suit different classes of natural hard water, such as that involving the substitution of hydrated lime by caustic soda. The use of sodium aluminate as an aid to efficient precipitation and sedimentation, especially in the case of raw waters which require a long settling period, is also dealt with in some detail.

The booklet also contains informative sections devoted to the use of various products of I.C.I. (Alkali) Ltd. for water treatment other than softening—such as sodium silicate, for the prevention of plumbo-solvency and iron corrosion by acid moorland waters, and the use of aluminium sulphate and alkali as a coagulant in the treatment of waters polluted with effluents. The removal by means of hydrated lime and calcium chloride of excess soda alkalinity in water due to the presence of sodium bicarbonate in solution is also discussed, while of special interest to the engineer is the outline of a method of removing oil from water to be used as boiler feed. Finally there is a brief note on the sterilisation of industrial water supplies by chlorination methods.

Considerable care has been exercised in the preparation of this concise survey of modern methods of water treatment. In times of drought and in the period immediately following a break waters are liable to increase greatly in hardness, and conditioning becomes more than ever necessary. When it is remembered that the products of such a diversity of industries as canning, paper-making, and textile manufacture, to mention only three, are directly affected by the quality of the water supply, the prime importance of water treatment becomes immediately obvious.

Trade Conditions in Switzerland

Some Effects of the Depression

IN a report on economic conditions in Switzerland, dated December, 1933, recently issued by the Department of Overseas Trade (H.M. Stationery Office, 2s. net) Dr. H. C. A. Carpenter, commercial secretary to the British Legation at Berne, states that in 1932 and 1933 Switzerland was under the shadow of the economic depression, and her national activities were chiefly devoted to holding her own under exceptionally difficult circumstances. Official economic policy was, in consequence, entirely directed towards saving the gold standard of the Swiss franc against all external attacks and internal inflational theories. In November, 1933, the franc was still at gold parity and the slightly diminished circulation was covered by a gold stock of 140 per cent. If "sight" liabilities (apart from notes) were all withdrawn in precious metal, the note circulation would still be covered by nearly 100 per cent. in gold.

Apart from the currency and note cover, however, conditions were less satisfactory. In the first six months of 1933, the average unemployment was 50 per cent. higher than in 1932 and four times as great as in 1931. There was an improvement in July to September; in fact in the latter month unemployment had sunk to 49,140 (compared with 49,532 in September, 1932) from 101,111 in January. The number of buildings completed was 50 per cent. less, although three-quarters of the 33,000 workers habitually unemployed in winter were able to find occupation through new building operations.

Diminution in Export Trade

Imports from January to September, 1933, were 1,098.6 million frs., some 208 million less than in the same period of 1932, due to some extent possibly to restrictions; exports were 545.6, *i.e.*, 52.7 million less. The adverse balance of trade, amounting to 553 million, forecasts some 740 million for the whole year and will be an improvement (in respect of balance of payments) on the figures of 1932 (962 million frs.). But the diminution of the export trade is a serious matter. Few articles exported could maintain their old position on foreign markets, owing to restrictions, depreciated currencies, moratoria, and competition of cheaper producing countries. With decreased business activity and diminished profits, public revenue is dwindling, whilst administrative costs are augmenting, particularly in the field of social services.

Swiss manufacturing industries are suffering badly from the crisis, especially the branches engaged in the export trade. The agricultural industry is feeling the effect of low world prices and has had to be helped by protective customs dues and by subsidies, and is still asking for more support, an example which is being followed by other industries. "The situation, bad as it is, and promising to become worse," writes Dr. Carpenter, "is not yet desperate. Switzerland still has great resources, the result of past savings, and though many investments are 'frozen' abroad, she should be able to withstand the crisis better and longer than many of her neighbours. In fact, if world conditions do not deteriorate hopelessly there seems sufficient reason to assume that she will be able to tide over her present difficulties and eventually to set her house in order. A great deal will undoubtedly depend on what happens in other countries."

The Rayon Industry

Principal imports into Switzerland during the first nine months of 1933 included 51,400,000 francs worth of chemicals, against a total of 74,400,000 francs for 1932. Exports during the same period included Dyestuffs, 48,200,000 francs, against a total of 58,100,000 francs in 1932; pharmaceuticals and drugs, 25,400,000 francs, against 34,000,000 francs; chemicals, 18,400,000 francs, against 22,900,000 francs.

No improvement took place in the rayon industry during the past eighteen months. In 1932 inland sales decreased by 15 per cent. at least, while exports declined by approximately 19 per cent. There was keen foreign competition on the domestic market, in spite of the quota restrictions introduced. In order to retain their footing on foreign markets, Swiss exporters were compelled to introduce cuts in their prices. Sales abroad were maintained at the cost of heavy sacrifices, and were severely handicapped by high customs duties, foreign exchange restrictions and the diminished purchasing capacity of foreign customers. The following export figures speak for themselves:—Weight (1932), 3,682.4 tons; (1931), 4,555.5 tons; percentage decrease 19.16. Value (1932), 23.1 mill. frs.; (1931), 38.3 mill. frs.; percentage decrease, 39.69. During the first nine months of 1933, sales abroad of rayon amounted in value to 16.2 million francs, as against 18.1 million francs for the corresponding period of 1932, and 30.8 million francs for that of 1931.

Production of Dyestuffs

The general trade depression and more particularly the prolonged crisis in the textile industry reflected unfavourably on the dye industry. It was impossible to maintain regular production and manufacturers found themselves obliged to introduce the four day week in order to prevent the dismissal of workmen on a large scale. The working week was thus reduced from 48 to 33½ hours. The works and the unemployment insurance, however, paid the greater part of the workers' loss in wages. These remained the same, namely, an average of Frs. 1.55 per hour. The depreciation in British, Japanese and American currency, allied with the difficulties resulting from foreign exchange restrictions exercised a very unfavourable influence.

The following export figures for aniline dyes and indigo illustrate the decline in this once flourishing industry:—1931, 71,152,302 francs, 8,397.0 tons; 1932, 56,905,879 francs, 6,347.7 tons. The figures in respect of value for the first nine months of the last three years are as follows, showing a slight improvement in the current year over 1932 (in million francs):—Exports of aniline dyes and indigo (1933) 47.3, (1932) 42.1, (1931) 51.9.

Pharmaceutical Industry

Generally speaking, pharmaceutical products and especially the high-class Swiss specialities are less liable to be affected by foreign competition or by trade depression than other less specialised commodities. Nevertheless, the Basle pharmaceutical industry has been hard hit by the prolonged world crisis and the resultant lowered standard of living in most countries. Moreover, the diminished budgets of hospitals and health insurance societies have had their effect on the sale of medicines. To this must be added the increasing restrictions in payments, which in 1932 produced almost impossible conditions in international trade. A decrease in local production was also due to the fact that, in order to evade high customs duties and import restrictions, a considerable portion of pharmaceutical products were manufactured in branch factories established abroad. Profits were reduced by loans from banks, necessitated by an increase in stocks and also by the compulsory reduction in prices introduced by certain countries, *e.g.*, Germany. The continual uncertainty as to whether the full value for goods delivered to foreign countries would be received forced the industry to measures of caution which has led to a further decrease of turnover.

In spite of these unsatisfactory conditions, which were already evident in 1931 and became acute in 1932, the financial situation of the pharmaceutical industry can, on the whole, be regarded as good and it is hoped that pharmaceutical concerns will emerge from the present depression without any permanent damage. Exports of pharmaceutical products fell from 2,408.6 tons, valued at 45.2 million francs in 1931, to 2,023.9 tons at 34.0 million francs in 1932. During the first three-quarters of 1933, exports of these products amounted in value to 25.4 million francs, as compared with 25.9 million francs for the corresponding period in 1932, and 34.0 million francs for that in 1931.

Sidelights at the Refrigeration Exhibition

The Testing of Insulating Materials

THE Refrigeration Exhibition, which remains open at the Science Museum, South Kensington, until the end of August, has some interesting aspects quite apart from exhibits illustrating different types of refrigeration machinery and the application of refrigeration to the preservation of foodstuffs.

Insulation and refrigeration are considered jointly in an exhibit intended to illustrate the physico-engineering work which is carried out at the National Physical Laboratory for the refrigeration industry. This illustrates the type of apparatus used in testing insulating materials by measuring the coefficient of thermal conductivity. A hot plate is sandwiched between two layers of the material under test with two cold plates on the outside. The hot plate is surrounded by a "guard ring" maintained at the same temperature as the hot plate to ensure that the flow of heat is normal to its surface. The hot plate is heated electrically, and the energy supplied is measured in electrical units. This quantity, together with the temperatures of the hot and cold plates, provides the data required for calculating the conductivity of the material. A number of insulating materials are also shown in section supported between two glass plates. The width of the sections shows roughly the thickness of the material to give approximately the same insulation.

Automatic Temperature Control

Automatic temperature control by thermionic relay is illustrated by two exhibits. In one case the apparatus consists of a thermionic valve, supplied with filament, anode and grid potentials from an A.C. supply, operated by an adjustable contact thermometer in the grid circuit. The heater lamp is controlled by a mercury switch magnetically operated by the anode current. The chief characteristics of the thermionic relay are that accurate and reliable working is obtained over the long periods of constant temperature or humidity required. Relays of this pattern are used, for example, for the temperature control of cold storage chambers, by controlling heat emission in opposition to the brine cooling; the temperature control of hot rooms; and the control of humidity in the investigation of forest products, etc. The second exhibit shows a development in the use of the thermionic relay to obtain fine regulation of temperature. The heater remains continually in operation, and the heat emission is regulated by a motor-driven resistance controlled by a thermionic relay.

The manufacture of ice on a commercial scale is illustrated by transparencies, and this exhibit is intended only to show the underlying principles. The brine in the tank is cooled by coils in the shape of a figure 8 in which the refrigerant from the compressor is evaporated. In each compartment of the coils are placed three cans containing the water to be frozen. In the larger commercial plants the ice is made in moulds immersed in a large brine tank containing calcium chloride brine at a temperature of about 16° F. In English practice rows of about eight or ten moulds are usually clipped together in frames and the brine is forced to circulate between and around them, returning through tunnels at the side of the tank which contain the evaporator coils.

Water Agitation

An important feature is the agitation of the water in the moulds which is essential for the production of clear transparent blocks. This is usually effected by allowing compressed air to bubble through the water in the mould by means of a small pipe known as a "down pipe" which passes down the outside of the mould and opens into the bottom. The air is usually delivered under pressure through a main passing along one side of the tank, flexible connections being made to the individual moulds, the air for this purpose having been previously passed through a dehydrator to prevent the formation of ice in the down tubes. Other systems of agitation, such as self-adjusting stirring rods and, in the case of the smaller plants, rocking moulds, are also employed. When the blocks are frozen to the centre the rows of moulds are hoisted from the brine and dipped in a thawing-off tank containing water at 60° to 70° F. in order to free the surfaces. The blocks are then tipped out down a slope to a loading platform.

In the sinking of mine shafts through quicksands or water-bearing strata, where the inflow cannot be dealt with by pumping, the freezing process has been conveniently adapted in accordance with the principles of a model which has been lent by the Mining Department, Armstrong College, Newcastle-on-Tyne. Here a ring of pipes is driven into the ground on a diameter slightly larger than that of the shaft to a sufficient depth to reach the bottom of the troublesome stratum. Each pipe consists of two concentric tubes of which the outer, which may be from 4 to 5 in. diameter is closed off at the bottom, while the inner, which is usually of $1\frac{1}{4}$ in. diameter, is left open at the bottom. Brine at about −6° to −9° F. is made to pass down the outer tube and return through the inner tube, all the outer tubes and all the inner tubes being connected with two ringed headers which are in turn connected with the brine pump and evaporator tank. By this means the water content of the ground is frozen, and the work of shaft sinking may be carried on as if through dry rock.

Manufacture of Margarine

The application of refrigeration in the manufacture of margarine is illustrated by a replica of a cooling section of one of the margarine factories of Unilever, Ltd., which shows the apparatus used, the refrigeration in this case being effected by the direct-expansion method with vertical ammonia compressors. The pipe lines are distinctively coloured to enable the different cycles to be followed. Another model shows a replica of the cooling section of one of the compound lard factories of Unilever, Ltd., the refrigeration in this case being effected by chilled glycerine-water solution being circulated through the cooling drum.

Another model shows the main items of a plant installed at the South Wales Refinery of the Anglo-Persian Oil Co., and illustrates the application of refrigeration to a particular refining operation. Oil containing finely divided wax in suspension is mixed with naphtha and is then cooled to a temperature of −10° F. or below. The cooling is carried out by means of an ammonia refrigeration plant, which cools brine for circulation through coils immersed in tanks containing the oil to be cooled. When the oil has reached the required temperature it is pumped to a battery of centrifugal separators. These machines consist of vertical bowls spinning at about 17,000 r.p.m. which separate the oil from the wax. As the wax is solid at these temperatures hot water is supplied to the bowl of each centrifugal machine to enable the wax to flow into its discharge pipe. The de-waxed oil is subsequently distilled, and forms the base for the manufacture of lubricating oils. The plant which this model illustrates is capable of chilling and separating 37,000 gallons of oil per day.

Italian Dyestuffs Industry

Increased Production in 1933

ITALY'S domestic production of synthetic dyestuffs amounted to 6,200 metric tons in 1933, compared with 5,700 tons in 1932 and 7,500 tons in 1929, the peak year. Increased production in 1933 was accompanied by a 10 per cent. rise in consumption. Imports were practically offset by exports, and the volume of domestic production accounted for approximately 83 per cent. of consumption. On a value basis, however, production accounted for only 50 per cent. of consumption, as Italian imports consist of the finer grades of dyes. The bulk of Italy's imports of dyestuffs come from Germany and Switzerland, with small quantities originating in France and elsewhere.

United States Chemical Industry

Continued Improvement in Foreign Trade

THE United States foreign trade in chemicals and allied products during the first quarter of 1934 exceeded the figures for the corresponding period of both 1933 and 1932. Chemical imports, amounting to $26,782,000, were 53 per cent. greater than in the first quarter of 1933 and 27 per cent. greater than in the similar period of 1932; exports totalling $29,297,000 were 35 and 17 per cent. more, respectively. Improvements were quite general in both quantities and values in all the various lines, though the largest gains occurred in raw materials used by industry.

Outstanding quantity increases in the import trade were made in varnish gums (46 per cent.), in fertilisers (67 per cent.), and in camphor, essential oils, carnauba wax, pyrites, coal tar dyes, many industrial chemicals, and perfume materials.

In exports of finished products, which have been suffering much larger losses during the past three years than the other groups, medicinal preparations were maintained at about the level of the first quarter of 1933, and some gains were made in pigments and paints and in toilet preparations. A few large increases were recorded in such exports as agricultural insecticides and sulphur, which doubled in quantities shipped; caustic soda and soda ash likewise made large gains; nearly all commodities included under industrial chemicals and industrial chemical specialities were considerably better than in the first quarter of 1933, and contributed to the 43 per cent. gain in total value of industrial chemicals, and to the 30 per cent. gain in chemical specialities.

Cellulose Solutions Regulations

Revised Draft Published

THE Cellulose Solutions Regulations, 1934, made by the Secretary of State under section 79 of the Factory and Workshop Act, 1901 (1 Edw. 7. c. 22), have now been published in revised draft, copies of which are obtainable from H.M. Stationery Office, price 2d. The following extracts are of general interest.

No fire, flame or open light or other agency likely to ignite *cellulose solutions* or *inflammable liquids* or the vapours thereof must be allowed within 20 feet of any *cellulose cabinet, cellulose space* or *store-room*, unless effectively separated therefrom by means of intervening *fire-resisting material*. All heating and electrical apparatus (including lamp fittings and resistances) liable to attain a temperature of 180° F., must be so situated or so protected as to prevent the deposition thereon of any solid residues resulting from the manufacture, manipulation or use of *cellulose solutions*. Effective steps must also be taken to remove any solid residues resulting from the manufacture, manipulation or use of *cellulose solutions* from all *cellulose cabinets* and *cellulose spaces* and also from all ducts, trunks, casings or fans used in connection therewith, and such residues shall be deposited in a safe place. No such removal shall be effected by scraping with iron or steel implements.

All stocks of cellulose solutions or inflammable liquids must be kept in (*a*) fixed storage tanks in safe positions, or (*b*) metal drums, cans, or similar vessels situated in store-rooms which must either be constructed of fire-resisting material or be in safe positions not less than 30 feet from any occupied building. The quantity of cellulose solution or inflammable liquid in any workroom must be kept as small as practicable having regard to the work carried on, and in the case of workrooms where cellulose solutions or inflammable liquid must, when not in actual use be kept in a metal cupboard or other receptacle at least as safe. Moreover, all drums, cans or similar vessels containing *cellulose solutions* or *inflammable liquids* must be kept securely closed when the contents are not in actual use, and must, after the contents have been expended, be removed without delay to a safe place outside the building, or to a specially constructed *store-room*.

Cellulose solutions or *inflammable liquids* containing more than fifteen per cent. by weight of benzene must not be procured or stored otherwise than in receptacles legibly marked as containing benzene.

Horace Cory and Co., Ltd.

Reduction of Capital Sanctioned

IN the Chancery Division on Monday, Mr. Justice Crossman had before him a petition by Horace Cory and Co., Ltd., chemical colour manufacturers, for sanction to a scheme of arrangement with its two classes of shareholders—preference and ordinary—and to confirming reduction of its capital from £150,000 divided into 50,000 preference and 100,000 ordinary shares of £1 each, to £55,000 by writing off 19s. from each ordinary share.

Mr. Hecksher, for the company, stated that the scheme involved the giving up by the preference shareholders of their rights in a special reserve fund with the exception of two years' dividend, one of which was to be paid immediately and the other retained for the increased participation from 5½ to 8 per cent. in future profits. The balance of the reserve fund would be released to the company.

His lordship said he supposed the preference shareholders considered that they had got a *quid pro quo*. What was taken from the reserve fund was applied to wiping off the company's losses.

Mr. Hecksher said that was so. The proposals had been accepted by overwhelming majorities of the two classes of shareholders. The scheme also involved the writing down of certain investments and a drastic reduction in the balance sheet of the value of the goodwill.

His lordship said he was satisfied it was a reasonable scheme and properly passed and that the reduction was a proper one. He accordingly approved it.

Chemical Matters in Parliament

Fatal Accident at Blackley

IN the House of Commons on June 21, Mr. Rhys Davies asked the Home Secretary what action, if any, was to be taken in connection with the recent accident at the Heaton Bleaching Mills, Blackley, Manchester, when four youths lost their lives.

Sir J. Gilmour replied that the reports showed that the accident arose from the accidental admission of scalding liquor into a kier, and that this was due to a momentary lapse on the part of a kierman. It would have been prevented if a recommendation made by a factory inspector some years ago had been observed, but this recommendation was not based on any specific provision of the Factory Acts and no breach of those Acts was involved. The question of the precautions to be taken against accidents from this cause was discussed at conferences with the industry in 1914, but, owing to the diversity of the plant, the agreement then reached provided only in general terms that the means adopted should be the best possible having regard to the circumstances of each case. Accidents of this kind had been very rare, but the recent case had shown the need for more specific requirements, and he had approved a proposal of the chief inspector to convene at an early date a special meeting of the trade associations concerned to discuss the position.

Mr. Nall-Cain asked the President of the Board of Trade, on June 19, whether, in view of the fact that West African oil-seeds were now subjected to an embargo by Germany and to prohibitive tariffs by the United States of America and other countries, thus causing serious loss to the West African trade in Liverpool, he could state what steps the Government intended to take to assist that trade in the matter.

Sir P. Cunliffe-Lister replied that he was well aware of the increasing difficulties which were being experienced in disposing of Colonial oil-seeds in foreign markets. The whole matter was under constant consideration.

AN emergency organisation has been set up by Imperial Chemical Industries, Ltd., with the approval of the Ministry of Health, to assist local authorities which are experiencing difficulties regarding the sterilisation of drinking water supplies consequent upon the drought. Two hundred rural districts are affected, and advice and assistance are to be given free.

Letters to the Editor

Vitamins in Foodstuffs

SIR,—An editorial note on the "Diamond Jubilee of Margarine" in THE CHEMICAL AGE of June 16 points out that vitamins A and D have been introduced into certain foodstuffs, but makes no mention of the quantities in which they have been introduced. This is a vital point; for vitamins to be most beneficial they should be consumed in constant amounts.

As far as I know, and this is supported by a recent statement in the "Pharmaceutical Journal," the proportions in which vitamins occur in any particular natural product are not constant. In pointing this out I do not mean to deprecate the addition of vitamins A and D to margarine, but merely to show that scientists would scarcely have gone to the trouble they have done to produce an element containing vitamins in constant amounts if they were already so available in margarine.

Success was only recently achieved after many years of experiment and research, when scientists discovered the element, radiostoleum, which contains vitamins A and D in accurately measured quantities. This, of course, is a product of the laboratories, and not of nature. I do not mean that it is not good to consume vitamins in their natural form—milk, fruit, eggs, butter and so forth—but it must again be insisted that where the need for vitamin intake has become clinically imperative such a natural method is practically useless, the only satisfactory intake being by way of measured and standardised products.—Yours faithfully,

GEORGE A. GREENWOOD.

The White House, Ridgeway, Stanmore.

Associated Dyers and Cleaners, Ltd.

Drastic Reorganisation Schemes

THE directors of Associated Dyers and Cleaners, Ltd., state in their report for 1933 that they have accepted the conclusions reached by a committee appointed by the board to "advise on vital matters of policy." Drastic steps are to be taken to avoid a continuance of trading losses, and the advisory committee states that the capital will require reconstruction and writing down, but to what extent it is not yet possible to determine. The decline in profits from 1928 to 1931 and the losses subsequently incurred are said to be due to falling sales, owing partly to the trade slump, lack of co-operation between members of the board, excessive cost of obtaining business owing to lack of co-operation between the Perth and Acton factories; excessive processing costs due to obsolete machinery and bad factory lay-out; unnecessarily prolonged price-utting, and lack of effective control in the working and sales sections.

The directors point out that steps taken to relieve the position include reorganisation of the Acton factory, increasing the general level of prices, and continuing to close redundant shops. Trading results have improved for five months ended May 31 to the extent of about £17,000 over the corresponding position in 1933. The board proposes the appointment of a formal committee of investigation. The net loss for 1933 is shown at £65,539, against a loss of £48,869 for 1932. This debit has been dealt with by an equivalent deduction from general reserve which now amounts to £46,287. The preference dividend is paid to April, 1932. No ordinary payment has been made since 1930.

THE Chemical Divisional Council of the British Standards Institution has decided to adopt 20° C. (international temperature scale) as the standard temperature for British standard volumetric glassware. The decision to adopt this temperature was reached after careful consideration of current practice in the British Empire and foreign countries and a brief account of the considerations which led to the decision is given in the Report which has been published as No. 554—1934. Copies of this report can be obtained from the British Standards Institution, Publications Department, 28 Victoria Street, London, S.W.1, price 2s. 2d. post free.

Rothamsted Experimental Station

Professor Armstrong on the Need for Clean Milk

THE purchase by the Lawes Agricultural Trust of the farm and lands of the Rothamsted Experimental Station, Harpenden, was celebrated on June 20, when the deeds were formally handed over to the trustees by Mr. Walter Elliot, Minister of Agriculture. The purchase was made possible by public subscriptions amounting to £35,054.

Lord CLINTON, who presided, said that the work Mr. Elliot had done on the marketing side of agriculture had created a new hope in the minds of agriculturists. Referring to the purchase of the Rothamsted land, he said it was not always to the advantage of a tenant farmer to become his own landlord; but there came a time when estates had to be sold and then the tenant had to consider what his position was to be. If they had not got possession of Rothamsted they would not only have lost the home which had been theirs for some 90 years, but they would have lost records of incalculable value.

Sir JOHN RUSSELL, director of the station, spoke of the world-wide interest taken in the Rothamsted Experimental Station, and said that their purpose was not to teach farmers how to farm but to give them information that could be used in solving their own problems on their farms.

Mr. ELLIOT, before handing over the deeds to Lord Clinton, paid a tribute to Sir John Russell, whom he described as a portent among scientific men; a man who could secure that scientists lay down in harmony together. That was not as easy as they might think from all they heard about the noble work of science.

Professor H. E. ARMSTRONG, a member of the Trust Committee, expressing thanks to Mr. Elliot, said that no clear idea of the vast importance of the Rothamsted Station was yet before the public. In the distant future when Mr. Elliot reviewed his career he would regard that occasion as probably the most momentous in the course of his official career, coupled as it was with the astounding action Mr. Elliot had taken on behalf of the organisation of agriculture. He had done far more than attempt to organise the production of, say, milk; he had begun to put the industry in order. There was before them at the moment the greatest struggle the world had witnessed in modern times—the struggle between industry, so called, and agriculture. This country had to make up its mind whether or not it was going forward on a basis of agricultural industry and not on the basis of commercial industry any longer. And for that purpose Rothamsted Station was bound to play a great part.

In no other place in the world had such experimental work been carried on for 90 years under close observation and most careful records kept of everything that had happened. The Rothamsted work hitherto had been almost entirely statistical. They had learned what the plant needed; they had learned little as yet what it could produce. Quality had scarcely been tested. They now knew, and he asserted that if animals and human beings were properly fed there would be very little disease. He begged the Minister of Agriculture, in concert with the Minister of Health, to consider that great problem and see if they could do something more than sell milk; if they could do something to make milk worth selling. Milk, on the average, was not worth selling. They ought to see that they got clean milk. The medical profession knew nothing about milk; it was only afraid of it.

THE Peruvian Ministry of Public Works is investigating the possibilities of exploiting the sodium-nitrate deposits found in the pampas of the Sihuas region in the Department of Arequipa. It is expected that when the engineer's report is available the State will issue the necessary legislation to initiate and protect the establishmen of this industry in the country. Should production be established it is expected that it would be highly beneficial to national agriculturists, as in recent months many complaints have been received as to the very small amounts of bird guano available. The operation of these deposits would be an exceptional source of wealth to the region concerned, and would also employ many people.

Continental Chemical Notes

DIBUTYL PHTHALATE is now being produced by a Moscow salicyclic acid factory on a fairly considerable scale, the reported output for June being 8 tons, whilst 10 tons is the contemplated figure for July.

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A PROJECT in the Leningrad district concerns the production of motor spirit, wax, paraffin, phenol, etc., from shale and peat. In addition, waste shale ash is expected to form the basis of 500,000 tons of Portland cement per annum.

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CONTINUING THEIR PROSPECTING OPERATIONS in Hanover, the Itag (Internationale Tiefbohr A.G.) in association with the German Vacuum Oil Co., have made a fresh find at 1,260 metres depth with an initial daily yield of over 100 tons crude oil.

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NEW CHEMICAL ENTERPRISES recently approved by the Italian Ministry of Corporations include ammonium nitrate and concentrated nitric acid (Soc. Nazionale Chimica, of Milan), metallic sodium (the same) and methyl alcohol (Soc. Ammonia e Derivati, of Sinigo).

* * *

DEMAND FOR NITROGEN products was well maintained during 1933, states the annual report of the State Coal Mines of Limburg, and the plants were in uninterrupted operation throughout the entire year. The output corresponded to 52,400 tons of nitrogen as against 50,100 tons in 1932.

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TH. GOLDSCHMIDT A.G., of Essen, announce a considerably increased turnover of nearly 3,500,000 marks during 1933 (against 3,000,000 in 1932). After writing off a total of 1,128,196 marks, a net profit of 362,072 marks (against 17,031 marks) is carried forward. The quantity turnover increased in 1933 by approximately 11 per cent. and the export trade also progressed in spite of sharpened restricticton and falling prices. The number of employees increased by about 25 per cent.

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AN IMPORTANT GERMAN CHEMICAL MERGER is anounced in "Metallbörse," the parties being Schering-Kahlbaum A.G., and the Kokswerke and Chemische Fabriken A.G. For trading purposes the Schering concern is absorbed by Kokswerke and its turnover paid into the latter's account. Shareholders of Schering receive in return a proportional dividend which is, however, fixed at 8 per cent. minimum. Other concerns already closely linked with Kokswerke and Chemische Fabriken are Konkordia Bergbau A.G., Vogtländer and Sohn A.G., Duco-Fabrik and Vereinigte Dachpappenfabriken A.G.

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ACCORDING TO THE RUSSIAN PERIODICAL "Sa Industrialisaziju" (quoted in "Chemische Industrie" of June 23), an alcohol-manufacturing plant based upon wood hydrolysis by the Scharkow yeast fermentation process has been operating since January in the Leningrad district. Russian experts maintain that wood saccharification is only economically feasible in conjunction with a large production of alcohol. The Soviet authorities have under consideration an ambitious scheme for erecting ten additional large factories in the near future. The residual lignin, in briquette form, will serve for heating the factories, whilst the alcohol will be used in the main as motor fuel and as a raw material for synthetic rubber.

* * *

LUBRICATING OILS resulting from high-pressure (60 atmospheres) condensation of ethylene with cyclic hydrocarbons in presence of aluminium chloride were described by H. Schildwächter before the recent Cologne meeting of the Verein Deutscher Chemiker ("Chem.-Zeitung," June 23). Dark brownish-red and green fluorescent viscous oils were obtained in almost theoretical yield from naphthalene and tetraline, although widely differing reaction temperatures (100° to 110° C. and 310° C. respectively) were necessary. The crude condensation product from naphthalene ultimately gave an 85 per cent. yield of pale, non-darkening lubricant with a hydrogen content of about 11 per cent.

EXTENSIVE MERCURY DEPOSITS have been located in the Donez Basin in Russia. Following their impending exploitation in the near future, reported in "Metallbörse," of June 20, imports of the metal will cease.

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THE CHEMISCHE FABRIK BUCKAU registered a decline in gross profit in 1933, the 1932 figure of 4,600,000 marks comparing with 4,000,000 marks in the past year. A slight increase in net profit was nevertheless achieved and a dividend of 4 per cent. distributed upon the 8,500,000 marks share capital.

New Dyestuffs

Modern Fast to Light Colours

MODERN fast to light shades on cotton piece suitable for discharging work with hydrosulphite are given in a new colour card issued by The Geigy Colour Co., Ltd. The forty-five dyeings displayed in this card were made on the jigger with addition of 10-40 per cent. glauber's salt according to depth of shade. The first few passages are dyed at the boil and when the requisite amount of salt has been added, the steam is shut off and dyeing continued for a certain time.

ERIO FAST FLOXINE 2GL, introduced by The Geigy Colour Co., Ltd., is claimed to be the yellowest and brightest of these level dyeing, fast-to-light acid colours. As with the two older 3BL and BL brands the new product is distinguished by exceptionally level dyeing properties and very good fastness to light. It can be used not only as a self colour but also as a red component for the most varied fashion shades in producing dyeings fast to light and perspiration on ladies' dress goods, knitting and carpet yarns. It is particularly recommended for use in combination with Erio Flavine 4G Conc, Erio Fast Orange GL, Erio Fast Brown 5RL and the different brands of Erio Anthracene Brilliant Blues. It is practically unaffected by chrome and is therefore suitable for shading chrome dyestuffs, taking into consideration that the shade becomes somewhat duller. Cotton and all artificial silks including acetate silk effects remain white, whilst silk is slightly stained.

Merseyside Industries

Openings for Boys and Girls

UNDER the title of "Merseyside Employments for Boys and Girls: The Manufacturing Industries," the Liverpool Education Committee, in co-operation with the Ministry of Labour, the education committees of Birkenhead, Wallasey, Waterloo and District and the Bootle Juvenile Advisory Committee, has issued the ninth of a series of pamphlets dealing with the various occupations open to young people in the area. The ultimate intention is to present a complete record of all the employments—industrial, commercial and professional—open to young people and adults in the Merseyside area.

The latest pamphlet aims at providing parents, teachers, social workers and others with the detailed information that will enable them to advise young persons of school leaving age or over in selecting their future careers, and an important secondary aim is to stimulate on the part of young people themselves an intelligent interest in their future occupations. The chief features of the pamphlet are that all the industries, great or small, are considered separately and an attempt has been made to suggest the atmosphere and nature of each sphere of work and the particular personality suited to it. Information is given regarding conditions of employment, rates of wages, where possible, trade associations, periodicals recommended for study and reading, and books in the Merseyside libraries bearing upon the respective industries. Information is also given regarding facilities for continued education. All the statements concerning wages and trade conditions have been verified by practical authorities engaged in the respective occupations.

News from the Allied Industries

Iron and Steel

GERMANY INCREASED her raw steel production during May. The production for the month was 989,273 tons, against 977,576 in April, which month had one more working day. The average daily production was 43,012 tons, as against 40,732 tons in the previous month.

Cement

MR. N. M. JENSEN (deputy-chairman) presided at an extraordinary general meeting of the Tunnel Portland Cement Co., Ltd., in London, on June 23, when resolutions were agreed to for giving a share bonus to existing shareholders by capitalising £200,000 from reserve, thus increasing the ordinary share capital to £400,00. It was also decided to split the ordinary shares into 10s. shares, dividing them into 600,000 "A" shares and 200,000 " B " shares, ranking alike with the exception that the " B " shares would carry no votes. In addition, the board proposed to make an issue of a further 400,000 " B " ordinary shares of 10s. each.

Mineral Oil

THE VACUUM OIL CO., LTD., is applying to the court for consent to a reduction of £1,000,000 in its capital. In recent years the company built a number of tank steamers in this country, the capital outlay involved in their construction amounting to over £1,000,000. To provide for the cost of these vessels the capital was successively increased to its present amount of £1,750,000. Several of these tankers have now been sold to a company operating vessels wholly engaged in the transport of petroleum products, and as a result of this sale the Vacuum Oil Co. has capital considerably in excess of its present requirements. The sole reason for the application to the court is therefore to enable this surplus to be returned to the shareholders, and the reduction in no way affects the company's normal trading activities.

Dyestuffs

THE FRENCH Chemical Trust (Kuhlmann) reports a relatively prosperous year's business. The total turnover was 6 per cent. more than that for 1932, but turnover in the second half of the year was less than that for the first half. In the dyes section business was 10 per cent. greater than in 1932, and in heavy chemicals an important improvement (by 4 per cent.) was also realised. The Trust's business in fertilisers was uneven, as the agrarian depression diminished sales, while the Government enforced a reduction in prices of nitrates. The sales of superphosphates were again sharply diminished. The net profit for the year was not quite 37,000,000 francs, against just over 38,000,000 francs the previous year. Of the whole product of the Trust 22 per cent. was exported.

China Clay

THE CHINA CLAY SHIPMENTS for May reveal a pronounced improvement in the trade and afford abundant evidence of returning activity in the china clay industry. Although there is still a slump in the American markets, the home, Continental and foreign consumption of British clays is gratifying. An interesting feature in the shipping record for May is the remarkable output at Par Harbour through its close proximity to the china clay works and the mobility of the motor transport that has been established. The details of the shipments are as follows:—Fowey, 37,154 tons of china clay; 3,014 tons of china stone; 1,163 tons of ball clay. Par, 14,027 tons of china clay; 1,323 tons of china stone. Charlestown, 5,748 tons of china clay; 438 tons of china stone, Penzance, 1,361 tons of china clay. Padstow, 828 tons of china clay. Looe, 190 tons of china clay. Plymouth, 177 tons of china clay. By rail throughout, 5,439 tons of china clay, making a total of 64,924 tons of china clay, 4,775 tons of china stone, and 1,163 tons of ball clay; aggregating a tonnage of 70,862 tons, which represents an increase of over 11,000 tons, compared with the preceding month.

Safety Glass

SPEAKING at the statutory meeting of shareholders of Lancegaye Safety Glass (1934), Ltd., on June 23, the chairman (Mr. M. Gordon Liverman, J.P.) reported progress both in regard to sales and production.

Non-Ferrous Metals

AFTER PROTRACTED negotiations the Finnish Government has granted the Mond Nickel Company a concession to exploit about 135 square kilometres of nickel-bearing orefields in the Petsamo district. The company has undertaken to begin prospecting operations at the latest in May, 1935. Commercial exploitation is granted for 40 years, and the annual nickel output after the third year is fixed at 2,000 tons. According to an estimate the Finnish Government will receive royalties amounting to about 5,000,000 marks annually.

Artificial Silk

PRESIDING at the annual meeting of British Bemberg, Ltd., on June 22, Mr. William T. Cave (the chairman) said that the results were an improvement on the previous year and were encouraging, but were not yet such as might be regarded as satisfactory. The increased spinning production which became available the latter part of last year would be available for the whole of the current year, but he was not prepared to make any forecast of results, which must depend upon various factors other than increased production.

Beet Sugar

AT THE ANNUAL MEETING of the Ipswich Beet Sugar Factory, Ltd., on June 22, Colonel Sir G. L. Courthorpe said the average payment to the growers per ton, taking into account the average sugar content, was 37s., as against 41s. 1d. for the previous year, the fall in the level of sugar prices having materially affected the calculation. The balance sheet showed that their financial position had been further strengthened, and the board felt gratified with the results, and also with the prospects for the coming year.

Paper

THE DALSHOLM PAPER MILLS, Maryhill, Glasgow, are about to be reopened after having been closed down seven or eight years ago owing to depression in trade. Formerly wrapping papers were produced, but the mill will now concentrate on box boards, in the production of which, it is stated, only one other important concern is engaged in Scotland. The decision to restart the mill is due to the improved prospect for home manufacturers owing to the 20 per cent. ad valorem duty now imposed on imports from abroad. A new company, with Sir Robert Wilson as chairman, is being formed to carry on the business, which will provide employment for a fair number of workers.

PRESIDING at the final meeting of Combined Pulp and Paper Mills, Ltd. (in voluntary liquidation), on June 20, Mr. J. W. Vincent, the liquidator, said that at the date of liquidation, and subject to such damages as might prove to be recoverable, there remained only £70 out of the capital (including premiums) issued by the company at a figure of £1,092,500. That did not by any means represent all the losses sustained by investors, seeing that there had been dealings in the shares at prices of about £4 per £1 ordinary share and 16s. per 1s. deferred share. He had paid to creditors £1,240, leaving a balance in hand of £5,930. The money available for return of capital fell to be divided among the holders of 663,449 ordinary shares (36,551 ordinary shares having been surrendered), subject to his remuneration, the cost of distributing the dividend and the final winding-up. He asked the contributories to approve the payment of fifteen hundred guineas as his remuneration. That would enable him to distribute £4,146 11s. as a first and final dividend of 1½d. in the £ to ordinary shareholders, the balance remaining to cover the cost of such dividend and completing the winding-up.

Weekly Prices of British Chemical Products

Review of Current Market Conditions

PRICES of most chemical products have been maintained, and business generally has been on a steady scale during the past week. There has been keen competition in the industrial chemicals section for formaldehyde and zinc oxide. A good seasonal demand for citric acid and tartaric acid is reported, and formic and oxalic acids remain good items. Acetone, sodium acetate and sodium chlorate are fairly active. Barium chloride, sodium sulphide, and carbonate of potash continue dull. Business in the coal tar products market has continued on the same scale as last week. Refined tar and creosote oil are in good demand, but pitch has not been in such good demand as was anticipated. Transactions in pharmaceutical chemicals have been fairly satisfactory, and prices are practically unchanged. There has been a good demand for hydroquinone. Business in acetanilide has improved during the week. Inquiry for calcium lactate has been rather limited. There have been further price changes in the essential oils market, including a further increase in the price of Japanese peppermint oil. Cananga, lemon and orange oils have been in fairly good demand.

LONDON.—Business continues steady with prices firm. The coal tar products market is quiet. Prices, however, remain steady, with the exception of cresylic acid, which has shown an improvement in price.

MANCHESTER.—Business in the chemical market here during the past week has been comparatively quiet in most branches. There has been a sprinkling of contract orders for delivery over the second half of the year or over shorter periods, and the bichromates have come in for a certain amount of attention in this respect now that the rates for July-December delivery have been fixed. Much the limited business that has been done, however, has been in respect of small parcels for prompt or near delivery positions, and with the beginning of the Lancashire industrial holidays this week-end traders in the chemical market are disposed to look for some measure of seasonal dullness over the next couple of months at least. Except for continued weakness in sulphate of copper price fluctuations during the week have been both few and narrow, and there is little reason to anticipate any departure from the steady conditions that have ruled for so long. The by-products, also have been maintained in most directions.

SCOTLAND.—The Scottish heavy chemical market shows little or no change over the past week, business generally being quiet.

Price Changes

Pharmaceutical and Fine Chemicals.—CITRIC ACID, 9d. per lb.

Essential Oils.—CITRONELLA, Java, 1s. 9d. per lb.; Ceylon, 1s. 6d.; LEMONGRASS, 4s. 6d.; ORANGE, sweet, 7s.; PEPPERMINT, Japanese, 4s.

Coal Tar Products.—LONDON: CREOSOTE OIL, 3½d. per gal. North, 4d. London; CRESYLIC ACID, 98/100%, 1s. 6d. per gal., 95/97%, 1s. 3d.

Manchester.—SULPHATE OF COPPER, £14 5s. per ton, f.o.b.; CARBOLIC CRYSTALS, 8d. to 8¼d. per lb.

All other prices remain unchanged.

General Chemicals

ACETONE.—LONDON: £65 to £68 per ton; SCOTLAND: £66 to £68 ex wharf, according to quantity.

ACID, ACETIC.—Tech. 80%, £38 5s. to £40 5s.; pure 80% £39 5s.; tech., 40%, £20 5s. to £21 15s.; tech., 60%, £28 10s. to £30 10s. LONDON: Tech., 80%, £38 5s. to £40 5s.; pure 80%, £39 5s. to £41 5s.; tech., 40%, £20 5s. to £22 5s.; tech., 60%, £29 5s. to £31 5s. SCOTLAND: Glacial 98/100%, £48 to £52; pure 80%, £39 5s.; tech. 80%, £38 5s. d/d buyers' premises Great Britain. MANCHESTER: 80%, commercial, £39; tech. glacial, £52.

ACID, BORIC.—Commercial granulated, £25 10s. per ton; crystal, £26 10s.; powdered, £27 10s.; extra finely powdered, £29 10s. packed in 1-cwt bags, carriage paid home to buyers' premises within the United Kingdom in 1-ton lots.

ACID, CHROMIC.—10½d. per lb., less 2½%, d/d U.K.

ACID, CITRIC.—9d. per lb. less 5%.

ACID, CRESYLIC.—97/99%, 1s. 8d. to 1s. 9d. per gal.; 98/100%, 2s. to 2s. 2d.

ACID, FORMIC.—LONDON: £43 10s. per ton.

ACID, HYDROCHLORIC.—Spot, 4s. to 6s. carboy d/d according to purity, strength and locality. SCOTLAND: Arsenical quality, 4s.; dearsenicated, 5s. ex works, full wagon loads.

ACID, LACTIC.—LANCASHIRE: Dark tech., 50% by vol., £24 10s. per ton; 50% by weight, £28 10s.; 80% by weight, £48; pale tech., 50% by vol., £28; 50% by weight, £33; 80% by weight, £53; edible, 50% by vol., £41. One-ton lots ex works, barrels free.

ACID, NITRIC.—80° Tw. spot, £18 to £25 per ton makers' works, according to district and quality. SCOTLAND: 80°, £23 ex station full truck loads.

ACID, OXALIC.—LONDON: £47 17s. 6d. to £57 10s. per ton, according to packages and position. SCOTLAND: 98/100%, £48 to £50 ex store. MANCHESTER: £49 to £53 ex store.

ACID, SULPHURIC.—SCOTLAND: 144° quality, £3 12s. 6d.; 168°, £7; dearsenicated, 20s. per ton extra.

ACID, TARTARIC.—LONDON: 1s. per lb. SCOTLAND: B.P. crystals, 11d., carriage paid. MANCHESTER: 1s. 0½d. to 1s. 0¾d.

ALUM.—SCOTLAND: Lump potash, £8 10s. per ton ex store.

ALUMINA SULPHATE.—LONDON: £7 10s. to £8 per ton. SCOTLAND: £7 to £8 ex store.

AMMONIA, ANHYDROUS.—Spot, 10d. per lb. d/d in cylinders. SCOTLAND: 10d. to 1s. containers extra and returnable.

AMMONIA, LIQUID.—SCOTLAND: 80°, 2½d. to 3d. per lb., d/d.

AMMONIUM BICHROMATE.—8d. per lb. d/d U.K.

AMMONIUM CARBONATE.—SCOTLAND: Lump, £30 per ton; powdered, £33, in 5-cwt. casks d/d buyers' premises U.K.

AMMONIUM CHLORIDE.—£37 to £45 per ton, carriage paid. LONDON: Fine white crystals, £18 to £19. (See also Salammoniac.)

AMMONIUM CHLORIDE (MURIATE).—SCOTLAND: British dog tooth crystals, £32 to £35 per ton carriage paid according to quantity. (See also Salammoniac.)

ANTIMONY OXIDE.—SCOTLAND: Spot, £26 per ton, c.i.f. U.K. ports.

ANTIMONY SULPHIDE.—Golden 6½d. to 1s. 1½d. per lb.; crimson, 1s. 3d. to 1s. 5d. per lb., according to quality.

ARSENIC.—LONDON: £16 10s. c.i.f. main U.K. ports for imported material; Cornish nominal, £22 10s. f.o.r. mines. SCOTLAND: White powdered, £23 ex wharf. MANCHESTER: White powdered Cornish, £21 ex store.

ARSENIC SULPHIDE.—Yellow, 1s. 5d. to 1s. 7d. per lb.

BARIUM CHLORIDE.—£11 per ton.

BARYTES.—£7 to £8 10s. per ton.

BISULPHITE OF LIME.—£6 10s. per ton f.o.r. London

BLEACHING POWDER.—Spot 35/37% £7 19s. per ton d/d station in casks, special terms for contract. SCOTLAND: £8 in 5/6 cwt. casks for contracts over 1934/1935.

BORAX, COMMERCIAL.—Granulated, £14 10s. per ton; crystal, £15 10s.; powdered, £16; finely powdered, £17; packed in 1-cwt. bags, carriage paid home to buyer's premises within the United Kingdom in 1-ton lots.

CADMIUM SULPHIDE.—2s. 7d. to 2s. 11d.

CALCIUM CHLORIDE.—Solid 70/75% spot, £5 5s. per ton d/d station in drums.

CARBON BISULPHIDE.—£30 to £32 per ton, drums extra.

CARBON BLACK.—3¼d. to 5d. per lb. LONDON: 4½d. to 5d.

CARBON TETRACHLORIDE.—£41 to £46 per ton, drums extra.

CHROMIUM OXIDE.—10¾d. per lb., according to quantity d/d U.K.; green, 1s. 2d. per lb.

CHROMETAN.—Crystals, 3½d. per lb.; liquor, £19 10s. per ton d/d.

COPPERAS (GREEN).—SCOTLAND: £3 15s. per ton, f.o.r. or ex works.

CREAM OF TARTAR.—LONDON: £4 2s. 6d. per cwt.

DINITROTOLUENE.—66/68° C., 9d. per lb

DIPHENYLGUANIDINE.—2s. 2d. per lb.

FORMALDEHYDE.—LONDON: £27 per ton. SCOTLAND: 40%, £28 ex store.

LAMPBLACK.—£45 to £48 per ton.

LEAD ACETATE.—LONDON: White, £34 10s. per ton; brown, £1 per ton less. SCOTLAND: White crystals, £33 to £35; brown, £1 per ton less. MANCHESTER: White, £34; brown, £31 10s.

LEAD NITRATE.—£28 per ton.

LEAD, RED.—SCOTLAND: £25 10s. to £28 per ton d/d buyer's works.

LEAD, WHITE.—SCOTLAND: £39 per ton, carriage paid. LONDON: £37 10s.

LITHOPONE.—30%, £17 10s. to £18 per ton.

MAGNESITE.—SCOTLAND: Ground calcined, £9 per ton, ex store.

METHYLATED SPIRIT.—61 O.P. Industrial, 1s. 6d. to 2s. 1d. per gal. Pyridinised industrial, 1s. 8d. to 2s. 3d. Mineralised, 2s. 7d. to 3s. 1d. 64 O.P. 1d. extra in all cases. Prices according to quantities. SCOTLAND: Industrial 64 O.P., 1s. 9d. to 2s. 4d.

NICKEL AMMONIUM SULPHATE.—£49 per ton d/d.

NICKEL SULPHATE.—£49 per ton d/d.
PHENOL.—8½d. to 9d. per lb. without engagement.
POTASH, CAUSTIC.—LONDON: £42. MANCHESTER: £36 10s.
POTASSIUM BICHROMATE.—Crystals and Granular, 5d. per lb. net d/d U.K. Discount according to quantity. Ground 5½d. LONDON: 5d. per lb. with usual discounts for contracts. SCOTLAND: 5d. d/d U.K. or c.i.f. Irish Ports. MANCHESTER: 5d.
POTASSIUM CHLORATE.—LONDON: £37 to £40 per ton. SCOTLAND: 99¾/100%, powder, £37. MANCHESTER: £37 to £38.
POTASSIUM CHROMATE.—6½d. per lb. d/d U.K.
POTASSIUM NITRATE.—SCOTLAND: Refined granulated, £29 per ton c.i.f. U.K. ports. Spot, £30 per ton ex store.
POTASSIUM PERMANGANATE.—LONDON: 9½d. per lb. SCOTLAND: B.P. crystals, 9d. MANCHESTER: Commercial, 8¾d.; B.P., 9¼d. to 9¾d.
POTASSIUM PRUSSIATE.—LONDON: 8¼d. to 8¾d. per lb. SCOTLAND: Yellow spot material, 8¼d. ex store. MANCHESTER: Yellow, 8¼d.
RUPRON (MINERAL RUBBER).—£16 10s. per ton.
SALAMMONIAC.—First lump spot, £41 17s. 6d. per ton d/d in barrels.
SODA ASH.—58% spot, £5 15s. per ton f.o.r. in bags.
SODA, CAUSTIC.—Solid 76/77° spot, £13 17s. 6d. per ton d/d station. SCOTLAND: Powdered 98/99%, £17 10s. in drums, £18 5s. in casks, Solid 76/77°, £14 10s. in drums; 70/73%, £14 12s. 6d., carriage paid buyer's station, minimum 4-ton lots; contracts 10s. per ton less. MANCHESTER: £13 5s. to £14 contracts.
SODA CRYSTALS.—Spot, £5 to £5 5s. per ton d/d station or ex depot in 2-cwt. bags.
SODIUM ACETATE.—£22 per ton. LONDON: £23.
SODIUM BICARBONATE.—Refined spot, £10 10s. per ton d/d station in bags. SCOTLAND: Refined recrystallised £10 15s. ex quay or station. MANCHESTER: £10 10s.
SODIUM BICHROMATE.—Crystals cake and powder 4d. per lb. net d/d U.K. discount according to quantity. Anhydrous, 5d. per lb. LONDON: 4d. per lb. net for spot lots and 4d. per lb. with discounts for contract quantities. SCOTLAND: 4d. delivered buyer's premises with concession for contracts.
SODIUM BISULPHITE POWDER.—60/62%, £16 10s. per ton d/d 1-cwt. iron drums for home trade.
SODIUM CARBONATE (SODA CRYSTALS).—SCOTLAND: £5 to £5 5s. per ton ex quay or station. Powdered or pea quality 7s. 6d. per ton extra. Light Soda Ash £7 ex quay, min. 4-ton lots with reductions for contracts.
SODIUM CHLORATE.—£32 per ton.
SODIUM CHROMATE.—4d. per lb. d/d U.K.
SODIUM HYPOSULPHITE.—SCOTLAND: Large crystals English manufacture, £9 5s. per ton ex stations, min. 4-ton lots. Pea crystals, £15 ex station, 4-ton lots. MANCHESTER: Commercial, £9 5s.; photographic, £15.
SODIUM META SILICATE.—£16 per ton, d/d U.K. in cwt. bags.
SODIUM NITRITE.—LONDON: Spot, £18 to £20 per ton d/d station in drums.
SODIUM PERBORATE.—LONDON: 10d. per lb.
SODIUM PHOSPHATE.—£12 10s. per ton.
SODIUM PRUSSIATE.—LONDON: 5d. to 5½d. per lb. SCOTLAND: 5d. to 5¾d. ex store. MANCHESTER: 4¾d. to 5¾d.
SODIUM SILICATE.—140° Tw. Spot £8 per ton d/d station, returnable drums.
SODIUM SULPHATE (GLAUBER SALTS).—£4 2s. 6d. per ton d/d. SCOTLAND: English material £3 15s.
SODIUM SULPHATE (SALT CAKE).—Unground spot, £3 15s. per ton d/d station in bulk. SCOTLAND: Ground quality, £3 5s. per ton d/d. MANCHESTER: £3 5s.
SODIUM SULPHIDE.—Solid 60/62% Spot, £10 15s. per ton d/d in drums; crystals 30/32%, £8 per ton d/d in casks. SCOTLAND: For home consumption, Solid 60/62%, £10 5s.; broken 60/62%, £11 5s.; crystals, 30/32%, £8 2s. 6d. d/d buyer's works on contract, min. 4-ton lots. Spot solid 5s. per ton extra. Crystals, 2s. 6d. per ton extra. MANCHESTER: Concentrated solid, 60/62%, £11; commercial, £8.
SODIUM SULPHITE.—Pea crystals spot, £13 10s. per ton d/d station in kegs. Commercial spot, £9 10s. d/d station in bags.
SULPHATE OF COPPER.—MANCHESTER: £14 5s. per ton f.o.b.
SULPHUR.—£10 15s. per ton. SCOTLAND: Flowers, £11; roll, £10 10s.; rock, £9; ground American, £10 ex store.
SULPHUR CHLORIDE.—5d. to 7d. per lb., according to quality.

Coal Tar Products

ACID, CARBOLIC.—Crystals, 8½d. to 8¾d. per lb.; crude, 60's, 2s. 1½d. to 2s. 2½d. per gal. MANCHESTER: Crystals, 8d. to 8½d. per lb.; crude, 2s. 1d. per gal. SCOTLAND: 60's, 2s. 6d. to 2s. 7d.
ACID, CRESYLIC.—90/100%, 1s. 8d. to 2s. 3d. per gal.; pale, 98%, 1s. 6d. to 1s. 7d.; according to specification. LONDON: 98/100%, 1s. 6d.; dark, 95/97%, 1s. 3d. SCOTLAND: Pale, 99/100%, 1s. 3d. to 1s. 4d.; dark, 97/99%, 1s. to 1s. 1d.; high boiling acid, 2s. 6d. to 3s.
ANTHRACENE OIL.—Strained, 4½d. per gal.
BENZOL.—At works, crude, 9d. to 9½d. per gal.; standard motor, 1s. 3½d. to 1s. 4d.; 90%, 1s. 4d. to 1s. 4½d.; pure, 1s. 7½d. to 1s. 8d. LONDON: Motor, 1s. 6½d. SCOTLAND: Motor, 1s. 6½d.
CREOSOTE.—B.S.I. Specification standard, 3¾d. to 4d. per gal. f.o.r. Home, 3¾d. d/d. LONDON: 3½d. f.o.r. North; 4d. London. MANCHESTER: 3½d. to 4½d. SCOTLAND: Specification oils, 4d.; washed oil, 4¼d. to 4¾d.; light, 4½d.; heavy, 4¼d. to 4½d.
NAPHTHA.—Solvent, 90/160%, 1s. 6d. to 1s. 7d. per gal.; 95/160%, 1s. 7d. to 1s. 8d.; 99/%, 11d. to 1s. 1d. LONDON: Solvent, 1s. 3½d. to 1s. 4d.; heavy, 11d. to 1s. 0½d. f.o.r. SCOTLAND: 90/160%, 1s. 3d. to 1s. 3½d.; 90/190%, 11d. to 1s. 2d.
NAPHTHALENE.—Purified crystals, £9 15s. per ton in bags. LONDON: Fire lighter quality, £3 to £3 10s.; 74/76 quality, £4 to £4 10s.; 76/78 quality, £5 10s. to £6. SCOTLAND: 40s. to 50s.; whizzed, 70s. to 75s.
PITCH.—LONDON: £3 to £3 1s. per ton f.o.b. East Coast port for next season's delivery.
PYRIDINE.—90/140, 6s. 6d. to 8s. per gal.
TOLUOL.—90%, 2s. 2d. per gal.; pure, 2s. 5d.
XYLOL.—Commercial, 2s. 2d. per gal.; pure, 2s. 4d.

Intermediates and Dyes

ACID, BENZOIC, 1914 B.P. (ex Toluol).—1s. 9¼d. per lb.
ACID, GAMMA.—Spot, 4s. per lb. 100% d/d buyer's works.
ACID, H.—Spot, 2s. 4½d. per lb. 100% d/d buyer's works.
ACID NAPHTHIONIC.—1s. 8d. per lb.
ACID, NEVILLE AND WINTHER.—Spot, 3s. per lb. 100% d/d buyer's works.
ACID, SULPHANILIC.—Spot, 8d. per lb. 100% d/d buyer's works.
ANILINE OIL.—Spot, 8d. per lb., drums extra, d/d buyer's works.
ANILINE SALTS.—Spot, 8d. per lb. d/d buyer's works, casks free.
BENZALDEHYDE.—Spot, 1s. 8d. per lb., packages extra.
BENZIDINE BASE.—Spot, 2s. 5d. per lb. 100% d/d buyer's works.
BENZIDINE, HCL.—2s. 5d. per lb.
p-CRESOL 34-5° C.—2s. per lb. in ton lots.
m-CRESOL 98/100%.—2s. 3d. per lb. in ton lots.
DICHLORANILINE.—1s. 11½d. to 2s. 3d. per lb.
DIMETHYLANILINE.—Spot, 1s. 6d. per lb., package extra.
DINITROBENZENE.—8d. per lb.
DINITROCHLORBENZENE, SOLID.—£72 per ton.
DINITROTOLUENE.—48/50° C., 9d. per lb.; 66/68° C., 10½d.
DIPHENYLAMINE.—Spot, 2s. per lb., d/d buyer's works.
α-NAPHTHOL.—Spot, 2s. 4d. per lb., d/d buyer's works.
β-NAPHTHOL.—Spot, £78 15s. per ton in paper bags; £79 5s. in casks, in 1-ton lots.
α-NAPHTHYLAMINE.—Spot, 11½d. per lb., d/d buyer's works.
β-NAPHTHYLAMINE.—Spot, 2s. 9d. per lb. d/d buyer's works.
o-NITRANILINE.—3s. 11d. per lb.
m-NITRANILINE.—Spot, 2s. 7d. per lb. d/d buyer's works.
p-NITRANILINE.—Spot, 1s. 8d. per lb. d/d buyer's works.
NITROBENZENE.—Spot, 4½d. per lb.; 5-cwt. lots, drums extra.
NITRONAPHTHALENE P.G.—1s. 0½d. per lb.
SODIUM NAPHTHIONATE.—Spot, 1s. 9d. per lb.
o-TOLUIDINE.—9½d. per lb.
p-TOLUIDINE.—1s. 11d. per lb.

Nitrogen Fertilisers

SULPHATE OF AMMONIA.—Home: £7 5s. per ton delivered in 6-ton lots to farmer's nearest station. Export: Nominal £5 17s. 6d. per ton f.o.b. U.K. ports in single bags.
CYANAMIDE.—£7 5s. per ton carriage paid to any railway station in Great Britain in lots of 4 tons and over.
NITRATE OF SODA.—£7 18s. 6d. per ton delivered in 6-ton lots to farmer's nearest station.
NITRO-CHALK.—£7 5s. per ton delivered in 6-ton lots to farmer's nearest station.
CONCENTRATED COMPLETE FERTILISERS.—£10 15s. to £11 6s. per ton according to percentage of constituents.
NITROGEN PHOSPHATE FERTILISERS.—£10 5s. to £13 15s. per ton according to percentage of constituents.

Latest Oil Prices

LONDON, June 27.—LINSEED OIL was easy. Spot, £22 15s. (small quantities 30s. extra); July, £21 5s.; Aug., £21 10s.; Sept.-Dec., £21 15s.; Jan.-April, £21 12s. 6d., naked. SOYA BEAN OIL was quiet. Oriental (bulk), June-July shipment, £12 15s. per ton. RAPE OIL was inactive. Crude, extracted, £27 10s.; technical refined, £29, naked, ex wharf. COTTON OIL was dull. Egyptian crude, £13; refined common edible, £16 5s.; and deodorised, £17e 15s., naked, ex mill (small lots 30s. extra). TURPENTINE was easier. American, spot, 42s. 9d. per cwt.
HULL.—LINSEED OIL.—Spot quoted £22 10s. per ton; June, £21 15s.; July-Aug., £21 17s. 6d.; Sept.-Dec., £22, naked. COTTON OIL.—Egyptian, crude, spot, £13 5s.; edible, refined, spot, £15 10s.; technical, spot, £15 10s.; deodorised, £17 10s. naked. PALM KERNEL OIL.—Crude, f.m.q., spot, £13, naked. GROUNDNUT OIL.—Extracted, spot, £18 10s.; deodorised, £22 10s. RAPE OIL.—Extracted, spot, £26 10s.; refined, £28. SOYA OIL.—Extracted, spot, £15 10s.; deodorised, £18 10s. per ton. COD OIL, 25s. per cwt. CASTOR OIL.—Pharmaceutical, 35s. 6d.; first, 30s. 6d.; second, 27s. 6d. per cwt. TURPENTINE, American, spot, 45s. per cwt.

Inventions in the Chemical Industry

Patent Specifications and Applications

THE following information is prepared from the Official Patents Journal. Printed copies of Specifications accepted may be obtained from the Patent Office, 25 Southampton Buildings, London, W.C.2, at 1s. each. The numbers given under "Applications for Patents" are for reference in all correspondence up to the acceptance of the Complete Specification.

Complete Specifications Open to Public Inspection

STARCH PREPARATIONS for producing adhesives, manufacture.—Henkel et Cie, Ges. Dec. 14, 1932. 30376/33.

AZO DYESTUFFS, manufacture and production.—I. G. Farbenindustrie. Dec. 16, 1932. 34463/33.

PRODUCTION of dyeings and printings by means of ester salts of leuco-vat-dyestuffs.—Durand and Huguenin, A.-G. Dec. 12, 1932. 34975/33.

AZO DYESTUFFS, manufacture.—M. J. G. Bader. Dec. 13, 1932. 34994/33.

1-HYDROXY-4-ALKOXYANTHRACENES, manufacture.—I. G. Farbenindustrie. Dec. 16, 1932. 35353/33.

YELLOW OXIDATION FERMENT and the dyestuff derived therefrom, production.—Schering-Kahlbaum, A.-G. Dec. 15, 1932. 35371/33.

ALKYLATED AND/OR ARALKYLATED 5 : 5 PHENYLETHYLHYDANTOINS, manufacture.—Chemical Works, formerly Sandoz. Dec. 16, 1932. 35378/33.

CONVERTING SOLID CARBON DIOXIDE into its gaseous condition, method and means.—J. Mosonyi. Dec. 15, 1932. 35383/33.

AMMONIUM SULPHATE, manufacture.—Union Chimique Belge Soc. Anon., and J. Guillissen. Dec. 17, 1932. 35385/33.

DEVELOPMENT of dyestuffs or the like on the fibre.—I. G. Farbenindustrie. Dec. 16, 1932. 35474/33.

DERIVATIVES of the anthraquinone series containing nitrogen and sulphur, manufacture.—I. G. Farbenindustrie. Dec. 17, 1932. 35475/33.

Specifications Accepted with Dates of Application

DYESTUFFS, manufacture and application.—British Celanese, Ltd., G. H. Ellis and F. Brown. Feb. 17, 1932. 411,877.

AQUEOUS SOLUTIONS of hydrochloric and sulphuric acids, manufacture and production.—J. Y. Johnson (I. G. Farbenindustrie). Dec. 2, 1932. 411,818.

POTASSIUM SULPHATE or mixed crystals of potassium sulphate and ammonium sulphate, production.—A. E. Cashmore, I. L. Clifford, and Imperial Chemical Industries, Ltd. Dec. 8, 1932. 411,820.

HYDROCARBON MIXTURES, in particular lubricating oils.—J. Y. Johnson (I. G. Farbenindustrie). Dec. 12, 1932. 411,893.

HIGH MOLECULAR HYDROGENATION PRODUCTS of rubber, polymerisation products of olefines, resins, and the like of highly viscous to lubricating oil character, manufacture and production. J. Y. Johnson (I. G. Farbenindustrie). Dec. 12, 1932. 411,894.

REMOVING PARAFFIN WAX from oils, especially lubricating oils. J. Y. Johnson (I. G. Farbenindustrie). Dec. 13, 1932. 411,866.

ABRASIVE ARTICLES bonded with a synthetic resin.—Bakelite, Ltd. (Carborundum Co.). Dec. 13, 1932. 411,846.

SENSITISING PHOTOGRAPHIC SILVER HALIDE EMULSIONS, process. I. G. Farbenindustrie. Dec. 15, 1931. 411,876.

CLEANING and pickling of metals and manufacture of products therefor.—Grasselli Chemical Co. Dec. 16, 1931. 411,907.

MANUFACTURE of adhesive and film-forming compositions.—Grasselli Chemical Co. Dec. 16, 1931. 411,908.

AZO DYESTUFFS, process for manufacture.—I. G. Farbenindustrie. Dec. 18, 1931. 411,915

METHOD AND MEANS for producing active charcoal or for reactivating spent charcoal.—F. Krczil. Jan. 4, 1932. 411,918.

ARTIFICIAL SILK, process and apparatus for manufacture.—British Bemberg, Ltd. March 5, 1932. 411,952.

ANTHRAPYRIMIDINES, manufacture and production.—I. G. Farbenindustrie. Sept. 17, 1932. 412,005.

BLEACHING of textile materials.—H. D. Elkington (C. B. Wood). April 12, 1933. 412,014.

CALCIUM FORMATE, production.—R. Koepp and Co., Chemische Fabrik A.-G. Aug. 13, 1932. 412,055.

LOW-CARBON CHROMIUM ALLOYS, method of manufacturing.—Wargons Aktiebolag. Aug. 22, 1932. 412,058.

VACUUM DISTILLATION of high-boiling-point products.—G. W. Riley, and G. Scott and Son (London), Ltd. Oct. 10, 1933. 412,080.

SINTERED HARD ALLOYS, manufacture.—Wolfram and Molybdaen A.-G. Nov. 18, 1932. 412,098. Nov. 24, 1932. 412,099.

FILTERS, more particularly for hydrocarbons.—J. Muller. Nov. 5, 1932. 412,100.

LUBRICATING OILS.—Germ Lubricants, Ltd., J. E. Southcombe, and M. A. Shenton. Nov. 7, 1933. 412,101.

CHROMIFEROUS AZO DYESTUFFS, manufacture.—Soc. of Chemical Industry in Basle. Nov. 8, 1932. 412,102.

AQUEOUS SOLUTIONS of hypochlorous acid, preparation.—Dr. G. Ornstein. Nov. 11, 1932. 412,105.

GLASS, manufacture.—Degea A.-G. Auerges. Nov. 19, 1932. 412,110.

Applications for Patents

DYESTUFF INTERMEDIATES, manufacture.—A. Carpmael (I. G. Farbenindustrie). June 20. 18279.

AZO DYESTUFFS, manufacture.—A. Carpmael (I. G. Farbenindustrie). June 20. 18280.

ANTHRAQUINONE DYESTUFFS, ETC.—Chemical Works, formerly Sandoz. June 19. (Switzerland, Aug. 17, '33.) 18174.

ANTHRAQUINONE DYESTUFFS, ETC.—Chemical Works, formerly Sandoz. June 19. (Switzerland, Jan. 17.) 18175.

HEAT CONVERSION of hydrocarbon oils.—Gasoline Products Co. June 16. (United States, June 16, '33.) 17891.

DEVELOPING SILVER-HALIDE EMULSIONS, ETC.—W. W. Groves (I. G. Farbenindustrie). June 18. 18043.

PULVERISING DEVICE.—W. W. Groves (I. G. Farbenindustrie). June 18. 18044.

REMOVAL OF IRON from solutions of aluminium sulphate.—W. W. Groves (Merrimac Chemical Co.). June 18. 18042.

ACID TRIPHENYLMETHANE DYESTUFFS, manufacture.—I. G. Farbenindustrie. June 15. (Germany, June 15, '33.) 17756.

VAT DYES.—Imperial Chemical Industries, Ltd., and E. Burgoine. June 15. 17781.

CONTROL of variable physical characteristics.—Imperial Chemical Industries, Ltd. June 20. 18298.

TREATING ANIMAL FIBRES.—Imperial Chemical Industries, Ltd. June 20. 18299.

LACQUERS, manufacture.—J. Y. Johnson (I. G. Farbenindustrie). June 14. 17639.

AZO DYESTUFFS, manufacture.—J. Y. Johnson (I. G. Farbenindustrie). June 14. 17640.

CONDENSATION PRODUCTS, manufacture.—J. Y. Johnson (I. G. Farbenindustrie). June 15. 17759.

WHITE PIGMENTS.—J. Y. Johnson (I. G. Farbenindustrie). June 18. 17995.

HYDROCARBONS from mineral oils, etc., manufacture.—J. Y. Johnson (I. G. Farbenindustrie). June 18. 17996.

AZO DYESTUFFS, manufacture.—J. Y. Johnson (I. G. Farbenindustrie). Nov. 18. 17997.

KETONES, production.—J. Y. Johnson (I. G. Farbenindustrie). June 18. 17998.

MANUFACTURE of 3-hydroxy-1-aldehydes.—R. E. Meyer. June 18. 17963.

ESTERS, manufacture.—N. Moskovits. June 15. (Austria, March 14.) 17773.

HYDROCARBON PRODUCTS, production.—H. E. Potts (International Hydrogenation Patents Co., Ltd.). June 19. 18086.

CHEMICAL FERTILISERS.—J. Radcliffe. June 14. (July 3, '33.) 17690.

SULPHONIC ACIDS, manufacture.—W. J. Tennant (Henkel et Cie, Ges.). June 15. 17787.

EMULSIFICATION of normally insoluble substances.—W. J. Tennant (Henkel et Cie, Ges.). June 18. 18039.

POLYPHOSPHATES, manufacture.—W. J. Tennant (Henkel et Cie, Ges.). June 19. 18163.

Chemical Trade Inquiries

The following trade inquiries are abstracted from the "Board of Trade Journal." Names and addresses may be obtained from the Department of Overseas Trade (Development and Intelligence), 35 Old Queen Street, London, S.W.1 (quote reference number).

South Africa.—H.M. Senior Trade Commissioner in South Africa reports that the South African Railway and Harbours Administration is calling for tenders (Tender No. 321), to be presented in Johannesburg by August 13, 1934, for the supply of 44,050 lb. of red lead, 2,850 lb. of white lead, 3,300 gallons of turpentine, and 14,280 gallons of white spirit. (Ref. B.Y. 7833.)

Brazil.—A commission agent in Rio de Janeiro wishes to obtain the representation of U.K. manufacturers of chemical and pharmaceutical products, paints and varnishes. (Ref. No. 675.)

Peru.—An agent in Lima desires to represent U.K. manufacturers and exporters of drugs and chemicals, etc., in Peru. (Ref. No. 677.)

From Week to Week

THE NATIONAL SMOKE ABATEMENT SOCIETY has removed its headquarters this week from 23 King Street to 36 King Street, Manchester, 2. The new premises are almost directly opposite the old offices.

MR. JOSEPH H. ELLISON, of Dalewood Drive, Beauchief, Sheffield, died suddenly at his home on Tuesday, aged 68. He was a director of Sheffield Chemical Co., and of J. Wilkinson and Son, chemical manufacturers.

PROFESSOR H. E. WATSON, of the Department of General Chemistry at the Indian Institute of Science, Bangalore, has been appointed to the Ramsay Memorial Chair of Chemical Engineering at University College, University of London, in succession to the late Professor W. E. Gibbs, dating from October 1.

IN A WRITTEN REPLY to a question by Mr. A. E. L. Chorlton, who asked what was the amount of oil obtained from British coal during 1933, Mr. Ernest Brown, Secretary for Mines, gave the following figures in the House of Commons on June 22: Crude benzol and other spirit 49,000,000 gal.; creosote, 65,000,000 gal. The tonnages of coal consumed in high and low temperature carbonisation processes from which the above products were obtained were 30.4 million tons.

AGREEMENT HAS BEEN REACHED between dyers of furnishing fabrics in Manchester which will result in the standard prices being charged from July 1. For some time certain concerns have been undercutting in this section, but all dyers have now been brought into line. The arrangement applies to the dyeing of curtains and furnishings, which fabrics are sold mainly in the home market. It will in no way affect the export trade, and will concern only a comparatively small part of the home textile trade.

THE PRESIDENT OF THE ROYAL SOCIETY, Sir Frederick Gowland Hopkins, was among a number of distinguished visitors at Morecambe on June 23, when a memorial tablet to John Edward Marr, Emeritus Professor of Geology at Cambridge University, was unveiled by the late Professor Marr's aged sister, Mrs. Walker Jones, of Kendal. The memorial is a bronze plaque set in a massive block of Westmorland green stone, placed in the wall of the house on Morecambe promenade where Professor Marr was born in 1857.

TWENTY-SEVEN MEMBERS of the office staff of Hall and Forster and Co., Ltd., manufacturing chemists, of Newcastle, were taken to Newcastle Infirmary on June 22, suffering from suspected poisoning after taking tea on the premises. Sixteen of them were detained. Mr. J. H. Forster was most seriously affected and lost consciousness after admission to the infirmary. The police have taken possession of the crockery used and have also taken samples of the water and tea for analysis, and the result will be submitted to the Medical Officer of Health, Dr. Charles.

THE DEATH OCCURRED on Tuesday at Park House, Stairfoot, Barnsley, of Mr. W. F. J. Wood, C.B.E., governing director of Wood Brothers, Glass Co., Ltd., of Barnsley and Wombwell. Mr. Wood was the first president of the Glass Research Association of Great Britain, which he was instrumental in forming during the war. During this period he directed all the resources of his firm to the manufacture of chemical and scientific glass ware, and for his services in this connection he was made a C.B.E. Other business interests included directorships of the British Chemical Plant Manufacturers' Association and of Barnsley Gas Co.

LORD MELCHETT was re-elected president of the British Science Guild, at the annual meeting held on June 12, at the Royal Society of Arts. He remarked that it was a matter of great importance that people who were directing the affairs of the nation should be kept in close touch with new developments. If they succeeded in doing that he believed they would perform the service for which they were originally constituted. Sir Richard Gregory, chairman, presented the annual report, which, in discussing the future finance of the Department of Scientific and Industrial Research, suggested that a definite part of the nation's tariff revenue, which is estimated at between £30,000,000 and £40,000,000, should be earmarked, after the current financial year, for the Department and the research associations. The ideal would be to allot 5 per cent. of the tariff revenue, or a lump sum of, say, £2,000,000 a year for current expenditure, financing unforeseen developments in any particular year, and for a permanent endowment of the Department. The aim should be, at the end of 20 to 25 years, or a still shorter period, to carry on the work on the annual income from trust funds, so that no further parliamentary votes would be needed. The capital necessary would be in the region of £20,000,000. In the immediate future the national industries would need all the help that statesmanship and science could give them, for competition froh other countries was likely to become more and more intense. A lecture on "Friction" was delivered by Professor E. N. da C. Andrade, Quain Professor of Physics in the University of London.

CANADA'S NICKEL PRODUCTION for April was the highest monthly output since 1929. The output was valued at 12,924,000 lb., compared with 10,437,000 lbs. in March. Production for the four months ended April 30 amounted to 39,898,000 lb., compared with 9,186,000 lb. for the same period in 1933.

RESPECTING AN APPLICATION by the Halifax Corporation to borrow £12,049 for the erection of new gas plant, a Ministry of Health inquiry was held at Halifax on June 21. Mr. C. B. Connell conducted the inquiry, which closed after technical details had been given by the gas engineer, Mr. W. B. McLusky.

PALESTINE POTASH, LTD., 62 Pall Mall, S.W.1, has increased its nominal capital by the addition of £150,000 in £1 unclassified shares beyond the registered capital of £400,000. The 540,000 ordinary shares of 1s. each have been consolidated into 27,000 shares of £1, and together with the 3,000 original unclassified shares of £1, are to be known as ordinary shares.

MR. L. BROWETT, C.B., C.B.E., principal assistant secretary of the Industries and Manufactures Department, has been appointed head of the Commercial Relations and Treaties Department of the Board of Trade, and Mr. W. B. Brown, C.B., C.B.E., assistant secretary, will succeed Mr. Browett. Following these appointments the President of the Board of Trade has appointed Mr. J. R. C. Helmore as his principal private secretary in succession to Mr. Brown, and Mr. H. Beer as assistant private secretary.

THE NET ESTATE of Sir Max Muspratt, Bt., of Liverpool, a director of Imperial Chemical Industries, Ltd., who died in April, is £197,508. He declared in his will that, having for many years spent a considerable proportion of his income and time on public and philanthropic work, he did not feel justified in charging his estate with specific bequests, but commended to beneficiaries under his will the duty of contributing for the good of the community such services, financial or otherwise, as their circumstances permitted.

A BOX CONTAINING FINE GOLD GRAIN valued at between £3,000 and £4,000 was stolen from a railway van at Birmingham on June 20. It had been consigned by Johnson, Matthey, and Co., Ltd., Hatton Garden, London, to their Birmingham office and was in course of delivery with parcels for other firms. As a L.M.S. van was standing unattended while the driver and his mate carried parcels to adjacent premises, a motor-car drove alongside. There were two men in the car and a third was seen to take the box from the rear of the van. He threw the box into the waiting car, sprang in, and the car was driven away down an almost deserted street.

SIR FREDERICK GOWLAND HOPKINS will unveil a plaque to William Hyde Wollaston at 14 Buckingham Street, London, W.1, on the afternoon of July 4. Wollaston, who was born in Norfolk in 1766 and died in 1828, was noted for numerous discoveries in chemistry and optics and as being the first to demonstrate the identity of galvanism and electricity. He was M.D. of Caius College, Cambridge, and practised for a time at Bury St. Edmunds but he abandoned his profession on removing to London and afterwards devoted himself wholly to science. He became a Fellow of the Royal Society in 1793 and founded its donation fund and the Wollaston fund of the Geological Society.

MR. JUSTICE GODDARD, in giving judgment in the Civil Court at the Liverpool Assizes on June 23, in an action in which a woman alleged that she contracted dermatitis from a fur coat, said that dermatitis cases were getting very common. Dermatitis had arisen even in respect of woollen articles. Wholesalers and retailers could easily protect themselves against bad luck by withholding the guarantee which the law implied or by insurance against risks. It was still known in the trade that there was considerable risk. His Lordship said he had no doubt the plaintiff suffered from dermatitis and got it from the coat, and he gave judgment for £134 in favour of Mrs. Elizabeth Kitcher, of Cranehurst Road, Liverpool, against Mr. J. Carrier, from whose warehouse Mrs. Kitcher selected a musquash coat.

ON A RECOMMENDATION by the Import Duties Advisory Committee, the Treasury has made the Import Duties (Exemptions) (No. 8) Order, 1934 (S.R. and O., 1934, No. 556), as a result of which Persian berries, quercitron bark extract, gum tragacanth, and sumach leaves (but not including ground sumach leaves) are added to the Free List, as from June 19. Except for a small quantity of sumach leaves, these articles, all of which are raw materials required by the textile finishing trades, are not procurable from home or Empire sources. The Advisory Committee is of the opinion that the removal of the 10 per cent. duty imposed on them by the Import Duties Act, 1932, will not only be of assistance to the textile industry, but will also encourage the tanning of light leathers in this country and assist in the development of the export trade in sumach extract. The order is published by the Stationery Office together with the recommendation of the Advisory Committee (Cmd. 4615).

Company News

Neuchatel Asphalte Co.—An ordinary dividend of 1¼ per cent., less tax, is announced for 1933. Payment will be made on July 26.

British Drug Houses, Ltd.—The usual quarterly dividend of 1¼ per cent. is announced, payable on the preference shares on June 30.

Thomas Firth and John Brown.—The directors have decided to pay the arrears of dividend up to December 31, 1933, on the 6 per cent. cumulative preference shares. This payment will be made on July 2 next.

Hadfields, Ltd.—The directors announce that, although the improvement in trade, referred to in the last annual report, has been maintained, they have decided to defer payment of the preference dividend due on June 30.

Reeves and Sons.—The report for the year ended April 30, 1934, states that the trading profit for the year was £21,166. The directors recommend a final dividend of 4 per cent., making 5½ per cent. on the ordinary shares, leaving £6,411 to be carried forward.

Webb's Crystal Glass.—The balance of profit and loss, for the year 1933, after bringing in £1,400 for tax recovered, amounts to £492, which it is proposed to carry forward.

Associated Fireclay Companies, Ltd.—A net profit of £15,611 is reported for the year to March 31 last, against a loss of £4,252 in 1932-33. The dividend on the preference shares for the six months to June 30, 1933, was announced in May, and the directors now announce payment for the year to June 30, 1934, to be made on that date.

Anglo-Scottish Beet Sugar Corporation.—The accounts for the year ended March 31, 1934, show trading profit after providing for interest, but before depreciation, of £42,272. The total available profit is £37,507, to which is added the balance brought forward of £17,716, making £55,223, which the directors recommend be carried forward.

The Anglo-American Oil Co.—The accounts for the year 1933 show that profits, after providing full depreciation and meeting interest on debenture stock, amount to £789,982, from which has to be deducted £555,229 loss brought forward, leaving a balance of £234,753 to be carried forward. For 1932 a net loss of £899,964 was returned. No dividend, it is understood, has been paid since 1930.

Powell, Duffryn Steam Coal Co.—The directors in their report state that trading profits are shown at £618,581 for the fifteen months to March 31 last, against £403,387 for the previous year, while the net balance, after interest and fees, is increased from £153,107 to £378,991. The sum of £92,500 is appropriated for depreciation and reserve additions, together with a sum of £53,275 which is transferred to general reserve, making a total fund of £250,000. After paying the preference dividends, the directors recommend a final ordinary dividend of 5 per cent., less tax. The carry-forward is raised from £74,076 to £108,787.

Continental Tintex and Dye Products.—The report for the year ended March 31, 1934, states that loss amounts to £953. More than £700 of this loss is reported to be due to liabilities not incurred by present directors. The Board recommends reducing capital from £200,000 to £20,000 by cancelling 4s. 6d. per share from the issued total of 625,212 5s. shares, and immediate creation of 7,200,000 6d. shares, restoring nominal capital to the former figure.

Sangers, Ltd.—The report for the year to March 31, 1934, shows a trading profit, including dividends, etc., and deducting fees, but before making tax provision, at £139,971. Tax provision absorbs £33,614, and the final dividend on the old ordinary shares is 11½ per cent., making 20 per cent. for the year. The new ordinary shares will receive 10 per cent., actual, and now rank pari passu with the old ordinary shares. The carry-forward is £67,469, against £42,593 brought in.

British Glues and Chemicals, Ltd.—A further moderate increase is reported in profits for the year to April 30, 1934. A net balance of £45,726 is shown, comparing with £45,361 in 1932-33, and with £31,468 in 1931-32. Additionally, a surplus balance of £5,000 has been transferred from tax reserve, and after payment of the year's dividend on the 8 per cent. preference shares to April 30, 1933, the carry-forward is raised from £35,020 to £43,746. No ordinary payment has been made since 1930.

New Chemical Trade Marks

Compiled from official sources by Gee and Co., patent and trade mark agents, Staple House, 51 and 52 Chancery Lane, London, W.C.2.

Opposition to the registration of the following trade marks can be lodged up to July 13, 1934.

Nat-Rol. B540,164. Class 1. Chemical substances for softening water. Watsons Water Softeners, Ltd., "Nat-Rol," Works, Orphanage Road, Watford. March 22, 1933.

Brilure. 550,905. Class 1. Chemical substances used in manufactures, photography, or philosophical research, and anti-corrosives. Jenson & Nicholson, Ltd., Goswell Works, Warton Road, Stratford, London, E.15. May 5, 1934.

Opposition to the registration of the following trade marks can be lodged up to July 20, 1934.

Derpon. 546,520. Class 1. Organic and mineral pigments. Oliver Wilkins and Co., Ltd., 83 Siddals Road, Derby. November 27, 1933.

Merolan. 542,164. Class 2. Chemical substances used for agricultural and horticutural purposes. British Dyestuffs Corporation, Ltd., Imperial Chemical House, Millbank, London, S.W.1. June 9, 1933.

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Metallurgical Section

January 6, 1934

Research on Light Metal Alloys

THE annual report of the Aeronautical Research Committee for 1932-33 reviews some of the work on light metal alloys which is in progress at the Royal Aircraft Establishment. Work on the corrosion and protection of light alloys includes an investigation of the factors which influence the tendency to inter-crystalline corrosion; the protection of magnesium alloys against corrosion, particularly with a view to shortening the time of treatment in film producing baths; and in collaboration with the National Physical Laboratory, research on the corrosion fatigue of duralumin and magnesium alloys with and without protective coatings. The influence of the structure of cast ingots on forging properties and on the properties of finished forgings is also being examined. Experiments have been made on the production of castings on a semi-technical scale using methods recently introduced by researches at the National Physical Laboratory. Experiments on the surface hardening of steels by nitriding are being continued, and tests are in progress on heat-resisting alloy steels which have been nitrogen-hardened with the aid of a film of copper to act as a stimulant in the nitriding process. In addition to work at the N.P.L. on the treatment of metals with volatile chlorides for gas removal, the corrosion of magnesium alloy has also been investigated. Other work deals with electro-plating, including methods for the prevention of plating brittleness.

Protection of Magnesium Alloys

THE extended employment of magnesium alloys for engineering purposes is seriously restricted on account of their tendency to corrode, with ultimate deterioration in mechanical properties. The discovery of satisfactory methods of protecting magnesium is therefore a matter of importance, for some of the alloys of this metal are desirable constructional materials on account of lightness combined with strength. The problem has recently been attacked by the development of protective films as bases for the usual painting processes, and several methods of producing such films by immersion in chemical solutions have been devised. Owing to the high chemical reactivity of magnesium itself, it is comparatively easy to produce protective films on its alloys, but only a minority of such films are successful. The patient investigation of this particular problem was stressed in the paper which Dr. G. D. Bengough and Mr. L. Whitby read before the Institution of Chemical Engineers early last month. Of five hundred different solutions for producing protective films there were two which really merited further investigation. One was the alum-dichromate process discovered by Sutton and Le-Brocq; the other was the application of selenium, used in particular for corrosion by sea-water. The latter process, due to Bengough and Whitby, has the great merit of simplicity and comparative cheapness. In some cases the light metal alloy is merely immersed in a solution containing 10 per cent. selenious acid and 0.5 per cent. sodium chloride, at ordinary temperature, for 5 to 15 minutes, when the surface becomes coated with selenium. The success of the process, however, is actually attributed to the self-healing properties of this film, for the magnesium surface beneath the selenium is coated with a much thinner film of magnesium selenide, which is decomposed by any water penetrating through the pores of the thicker selenium film. The hydrogen selenide thus formed then reacts with oxygen to give selenium, which seals the pores through which water has penetrated.

Scale Formation

RATES of scale formation on iron and a few of its alloys have been recently discussed by K. Heindlhofer and B. M. Larsen, in the "Transactions of the American Society for Steel Treating," (Vol. 21, No. 10). It is shown that the thickness of each layer, hence the thickness of the whole scale, increases as the square root of time and increases rapidly with rising temperature, according to an exponential relation. This has been confirmed for pure iron and pure copper, and for a few iron alloys, by experiments using relatively long periods of exposure and continuously weighing the sample during the scaling period. Ideal conditions, however, may not be fulfilled owing to a marked tendency towards blistering and the formation of cracks in the complex three-layer scale formed on iron in air. The tendency towards irregular growth is not nearly so marked in steam or carbon dioxide, where a single-layer scale usually forms, giving a much better degree of adherence. The substitution of carbon dioxide for air somewhat lessens the rate of scaling for iron, especially during the first few hours of exposure, in the temperature range 900 to 1,100°C. In steam at 700 to 1,100°C. the scaling rate is greater than in air; this is probably connected with the fact that the scale formed in steam is considerably more porous. From the results of a few tests on iron alloys, the authors conclude that carbon up to 1 per cent. has practically no effect upon scaling rate. Nickel up to 35 per cent., and aluminium up to 5 or 7 per cent., reduces scaling to about one-half or one-third of the extent existing for pure iron. Aluminium above 12 to 14 per cent. cuts the scaling rate down to a magnitude of 1 per cent. of that for pure iron.

Cheaper Iron and Steel

A REDUCTION in the cost of producing iron and steel was foreshadowed in a statement issued to shareholders of the Duffield Iron Corporation, Ltd., prior to the company's annual general meeting last month. For five years research has been carried on to ascertain the most suitable mechanical means for achieving this object. Preparation for the commercial plant was in progress when Mr. Duffield, in carrying out tests on the parent company's non-ferrous metal plant, discovered a phenomenon in heat treatment, which, if applied to the company's process for reducing iron ore, would considerably curtail the time of operation. Subsequent trials justified its adaptation to the treatment of iron ores and the directors, in embodying the principles in their commercial plant, foresee a reduction in both capital and operating costs. According to a report by Mr. A. Windsor Richards, the technical consultant to the company, a drying furnace is employed for the purpose of driving off any moisture present in the ore, at the same time preheating the ore before it enters the reducing furnace, where with its mixture of carbonaceous material, the iron is rapidly reduced to the metallic state and so passes to a melting furnace. Fuel consumption should thereby be reduced to one-third of that employed in existing practice, added to which a further saving can be effected by the use of ordinary slack coal.

An Abandoned Amalgamation Scheme

PLANS for the amalgamation of Dorman, Long and Co., and the South Durham Iron and Steel Co., have now been abandoned. Under the terms of the conditional agreement which had been entered into, the whole of the assets of the South Durham company were to be taken over by Dorman, Long and Co., in exchange for cash and shares. This arrangement, however, was conditional upon a re-organisation of the share and loan capital of the purchasing company, and the acceptance of the scheme by its debenture stockholders and shareholders, neither of which has it been possible to fulfil. In advising their shareholders of the position, the directors of the South Durham Iron and Steel Co. refer to the refusal of the Court to confirm the scheme and its offer to direct fresh meetings of stockholders and shareholders. That offer they were prepared to consider, but on the same day as the decision of the Court was given an application was made on behalf of the holders of certain Dorman, Long debenture stock for the appointment of a receiver. This was followed by a similar action on the part of holders of other debenture stock, both actions being dismissed by arrangement in view of the proposal to convene a meeting of debenture stockholders to approve a moratorium until the end of next March.

Blast-Furnace Gas Cleaning

THE blast-furnace gas cleaning installation for the Jamshedpur works of the Tata Iron and Steel Co. Ltd., Bombay, will be the largest in the world. It is being supplied by the English firm of Lodge-Cottrell Ltd., and will work on the electrostatic precipitation principle. A total volume of 14,000,000 cubic feet of gas will be dealt with per hour, as measured at normal temperature and pressure, and there is to be a guaranteed reduction in the dust content to not over 0.0088 grains per cubic foot, whereas the average dust content of the crude blast-furnace gas at the Tata Works often reaches 16 grains per cubic foot. The installation will consist of four pre-coolers, eight first-stage electro-filters (bringing down the bulk of the dust in dry condition), eight final coolers and eight second-stage electro-filters (to remove the residual dust and all the moisture in suspension). In the first stage from 97 to 98 per cent. of the total dust will be removed direct from the hot dirty gases, the remaining 2 to 3 per cent. of dust being removed in the second stage. In view of the fact that the cooling water available is already at a temperature of 80-100°F., the gases will be cooled within a range of 104-124°F., which is somewhat higher than usual. The cooling water, moreover, will have to be recirculated in view of the need for economy and the actual make-up is calculated to be only 5,000 gallons per hour. The placing of this contract with a British firm speaks highly for the efficiency of gas-cleaning plant of British manufacture, for it is understood that the engineers of the Tata Iron and Steel Co. made a detailed inspection of the gas-cleaning equipment which was available on the Continent.

The Past Year in Brief

FROM the industrial aspect the outstanding metallurgical event of the past year was possibly the opening of the new coking plant at the Irlam Works of the Lancashire Steel Corporation, Ltd., in May, for this marked an important step towards the manufacture of cheaper British steel. Other events in connection with the reorganisation of the iron and steel industry can also be recalled. For instance, Dorman, Long and Co., Ltd., decided to reconstruct the blast-furnaces at their Cleveland works, and the British (Guest, Keen, Baldwins) Iron and Steel Co., Ltd., revealed plans to recondition their Cardiff steelworks. Tin and copper also received attention, for the International Tin Committee took steps to stimulate the consumption of tin by setting up a Tin Research and Development Council, this action being followed by the copper producers with the formation of a Copper Development Association. Outstanding papers in non-ferrous metallurgy were read before the Institute of Metals at their annual meeting in March. On that occasion Mr. N. P. Allen gave some interesting information on the distribution of porosity in copper ingots, whilst a joint paper by Mr. W. Singleton and Mr. Brindley Jones dealt with the effect of the addition of tellurium to lead. A contribution to the study of inclusions in steel was presented at the annual meeting of the Iron and Steel Institute, in May, the joint authors being Professor A. M. Portevin and Mr. R. Perrin. At the autumn meeting of the Institute, in September, Mr. J. H. S. Dickenson, and Dr. W. H. Hatfield reported investigations which indicated little or no prospect of beryllium becoming a more useful addition to the group of metals already used in the manufacture of special steels. Ternary alloys of lead, containing cadmium and antimony or cadmium and tin, have been still further developed by the British Non-Ferrous Metals Research Association, whilst the British Cast Iron Research Association has given further attention to development work upon " inoculated " cast irons which show a marked increase in resistance to shock.

Alloy Irons and Steels for Nitric Acid Plant

By THOMAS McKNIGHT

WITH the co-operation of the research facilities of the metal producers and fabricators, much has been accomplished that a short time ago seemed almost impossible. Marked progress has been made in the production of corrosion-resisting alloys in rolled forms and tubes. Surface defects and laminations, once very common, are now comparatively rare, but meanwhile the resistance to attack in nitric acid, which is one of the most desirable qualities of the chrome alloys for this service, has fallen off. The average corrosion penetration recorded for samples recently tested is very much higher than the average obtained three years ago. The ammonia oxidation process is typical of the modern trend towards the economical application of metals and alloys. In addition to the common metals which are used wherever possible in equipment of this process, the following special metals are applied: Nickel, high-silicon iron, 18 per cent. chrome and 18 per cent. chrome 8 per cent. nickel alloys. Nickel is generally used for parts in contact with ammonia vapours, or preheated air and ammonia mixtures, after these gases have passed through the filters, as its tendency to decompose ammonia at the operating temperatures is lower than most other metals. In the form of castings, forgings or seamless tubes, nickel is amply strong, but welded seams have not proved entirely satisfactory as failures have occurred where temperatures exceeded the operating range. Welded construction was used in the fabrication of tubes in sizes which were not available as seamless drawn, but it has been found desirable, as a safety measure, to reinforce all such welded tubes with steel clamps. In some cases tubes have been made by boring and turning from solid forged bars in preference to the use of welding.

Nitric acid manufacture by the pressure system of ammonia oxidation has been made commercially possible through the application of special alloy irons and steels, which are surveyed by Mr. Thomas McKnight, of the Hercules Powder Co., Wilmington, in "Chemical and Metallurgical Engineering," September, 1933

For equipment used in concentrating nitric acid, above the strength (60 to 63 per cent.) produced by the oxidation process, the high-silicon irons offer more satisfactory corrosion resistance, for pressures in this process are relatively low and conditions favour the use of these somewhat brittle alloys. After the conversion of the ammonia-air mixture to oxides of nitrogen in the converter, all equipment in contact with the gases or acids under pressure is made of some type of high-chrome alloy, either the straight 15 to 18 per cent. chrome iron or 18-8 chrome-nickel alloy being used, depending on temperature and corrosion conditions or the fabrication difficulties encountered.

Casting Difficulties

Cost and comparative ease of fabrication favour the use of 18 per cent. chrome iron in the greater part of oxidation plant equipment, since it can readily be obtained in sheets, plates, bars, seamless tubes, forgings and castings, and its resistance to corrosion is satisfactory except in one or two locations where conditions are extremely severe. With careful design, these conditions may be modified so that the 18 per cent. chrome can be used throughout the system.

Since sound castings of chrome alloys are difficult to obtain, later designs have eliminated castings wherever possible. Patterns which offered no unusual difficulty in steel foundry practice were found almost impossible to produce in this alloy, to meet the specified tests. Welding of defects is not permissible and foundry rejections were excessive; however, the results obtained from accepted castings apparently justified the rejections. The foundryman should be consulted, and, if necessary, patterns modified to obtain the benefit of his experience. Corrosion resistance in samples from castings is comparatively poor, but the usual foundry practice calls for generous thickness and this to some extent compensates for more rapid corrosion.

Forgings are not entirely free from defects. A forged nozzle on a dismantled unit was found pitted almost through the riveting flange; apparently a large inclusion had corroded out. Subsequent experience with some forged tube sheets which developed surface cracks indicated that such failures may be caused by neglecting to trim the billet cut-off properly when forging. These alloys do not hammer-weld and projections forged in may form a fold or sliver which, with its accompanying embedded scale, is readily attacked by the acid. The application of welded construction to chrome alloys in this process has been limited because of the difficulty in securing reliable corrosion-resisting welds. Recent improvements in welding technique have changed this condition and welding may be extensively adopted in future designs. Several all-welded vessels have been installed in other processes and are under observation. Improper working may injure the structure of the chrome alloys. Hence, close control of all operations in fabricating is essential, since the condition of the metal has an important bearing on its corrosion-resisting qualities. Corrosion tests on heat-treated samples of 18 per cent. chrome iron indicate that temperatures above 1,450° F. should be avoided unless followed by annealing at not over 1,450°. We note, however, that certain laboratories specify annealing at 1,525° to 1,550°. Cold working apparently also has an undesirable effect on these alloys for nitric acid service, as this has been evident in equipment in service. In an absorption column recently dismantled after 200 days in service, producing acid, it was found that many internal caulked edges had fallen away and some of those remaining could easily be removed, although the plates and rivet heads showed no evidence of attack.

Use of High Temperature

A somewhat similar experience was partially responsible for the failure of vessels designed to vaporise nitric acid; here, caulked seams leaked after a few days in service and each recaulking of the joints extended the working life of the vessel for about a three-day period. In this case very special precautions were taken in fabrication; rivet holes were spot-faced and all fitting was as accurate as possible so that caulking was reduced to the minimum. This service was unusually severe and when the units were dismantled, local pitting was found on a number of rivet heads while adjacent rivets appear to be in perfect condition. The plates did not show much evidence of attack until the rivets were removed, and then it was found that the edges of the plates and some rivet holes were pitted, in some cases as much as $\frac{1}{8}$ in. deep, while the adjacent surface showed no appreciable attack.

The 18 to 8 chrome-nickel alloy finds a limited application in the oxidation process. The heat-resisting qualities of this alloy caused its selection for service in air preheaters, but its unstable characteristics within a certain temperature range which is approximately equualled in this service, have caused some modification in later designs and have led to the substitution of 18 per cent. chrome in parts formerly using the 18-8 alloys. Maintenance on these heat exchangers has been excessive on account of tube and tube-sheet failures.

The value of chrome alloys in nitric acid work depends on their resistance to corrosion. During their early use in nitro-cellulose equipment, it was observed that a large percentage of each lot of material installed soon had to be replaced because of failure by corrosion. Corrosion tests were developed to avoid the expense of installing and replacing material of inferior quality. This procedure is still followed and in general only approved material is used for plant construction. Accelerated corrosion tests are made in boiling nitric acid of 65 per cent. concentration, samples being sub-

merged in acid or suspended in vapours. Every sample thus tested shows measurable loss and this loss is continuous over any number of testing periods. Apparently the " protecting film " or " surface passivity " theories do not apply at these temperatures. Results of tests are calculated and tabulated in inches penetration for comparison. Since corrosion is seldom uniform, the actual depth of local pitting may be many times greater than the average penetration calculated from the accelerated test data.

Effect of Heat Treatment

Increased knowledge and improved facilities for the production of chrome alloys have not eliminated the need for corrosion tests. In a series of 90 tests made a few years ago from different 18 per cent. chrome heats, the highest penetration per year reported was 0.076 in., the lowest 0.017 in., and the average was about 0.035 in. These results are seldom matched to-day, in fact several samples tested recently have shown penetration of 1 in. per year.

With material of a given analysis the corrosion resistance may be varied by heat treatment; therefore, composition and heat treatment influence the results, but these are apparently not the only factors in the problem. An attempt was made three years ago to correlate data from a number of corrosion tests where all the information on analysis, heat treatment and working was available. The influence of individual constituents within the permissible range of specifications could not be traced but one important and somewhat surprising observation was made: where metal from the same heat was used in rolling $\frac{5}{8}$ in. and $\frac{3}{8}$ in. plate as well as sheets of 3/32 in. and 1/16 in. thick, the corrosion tests on the sheets were invariably superior to tests from plate samples. This would indicate that the nature of the work done in rolling is a factor in producing good corrosion resisting quality. All working of the alloys in fabrication of equipment should also be done under rigid specification, otherwise high corrosion-resistance worked into the metals in preceding operations may be reduced or destroyed by poor workmanship.

Electron and Hydronalium

German Expert Reviews Magnesium-Aluminium Alloys

INTERESTING information on the light metal alloys, electron and hydronalium were given in a lecture by Dr. W. Schmidt before the Verein Deutscher Chemiker in June last. Both these alloys have found wide application, and both are essentially alloys of magnesium and aluminium. Electron consists of 90 per cent. magnesium and the remaining 10 per cent. of aluminium, with small amounts of tin and manganese; hydronalium consists of 90 per cent. aluminium and 10 per cent. of magnesium.

According to Dr. Schmidt, it is now cheaper to produce magnesium than aluminium; the selling price of electron, on a volume basis, is less than that of aluminium because the expensive bauxite treatment required to produce a pure alumina for electrolysis is not required, and the consumption of KW hours per kg. of electron is not greater than for a kg. of aluminium, whereas the kg. of electron is 50 cent. greater. The aim to obtain a light metal cheaper than aluminium is thus attained.

Corroding Influences

From the chemical point of view, the behaviour of magnesium against corroding influences is important. The first magnesium manufactured was very sensitive to these; for example, a sample sent from Greisheim to Frederichshafen required to be cleaned from corrosion on arrival. From that stage we have advanced to the present-day sea-water resisting product, which has been made possible by the prevention of oxides and nitrades in the finished metal. Refining is carried out with a specially thick salt melt which will not flow out of the container. This consists essentially of carnallite, fluorspar and magnesium oxide which remains very viscous even at 700° C. Some water is added to this melt because up to 700°, this water is separated very slowly from the melt and carries hydrochloric acid with it. This acid vapour forms a layer over the surface of the molten metal and tends to prevent the metal from absorbing nitrogen from the air.

There is sufficient magnesium in both electron and hydronalium to support all the undesired reactions, but experience with electron has taught how to avoid contamination of the material. When sand castings of electron are made, boric acid has been found suitable to protect the metal. How far the purification of electron has been carried is shown by experiments with the eudiometer, by which the development of hydrogen in contact with sea water is measured. While electron, as made five or six years ago and was then the trade product, develops considerable quantities of hydrogen in contact with sea-water for two days, the present-day product yields only traces of hydrogen when exposed to the action of sea-water for two days. The most troublesome impurity is iron which, when present only in a few hundredths of 1 per cent., can be detrimental. Iron is almost insoluble in magnesium and extremely difficult to separate. By adding about 2 per cent. manganese at a temperature of 900° C. and then cooling down to 650°, the greater part of the iron will crystallise out with the manganese. In this way an original iron content of 0.016 per cent. can be reduced to 0.005 per cent.

Effect of Crystalline Structure

The action of the iron has also been studied in another way. A coarsely crystalline magnesium has been produced and the fact observed that all the crystals showing tendency to corrode lie in a certain direction in relation to the surface. Magnesium crystallises in the hexagonal system, and all crystals whose basis surface lies parallel to the metal surface have been shown to be those with corroding tendencies. Corrosion is thus a function of the growth of the crystals. The magnesium crystals grow more quickly in breadth than in length and thereby always deposits iron. For electron a pickling process has been developed, the pickling agent consisting of nitric acid containing 10 per cent. potassium bichromate. By immersion in this agent a yellow chromate is produced on the surface which, when lacquered, forms a strongly protective surface against corroding influences which is even effective for welded parts. As a welding flux, a mixture of the fluorides of potassium and lithium is used.

At the present time, a large variety of large and small castings of electron are made, including wheels for motor buses. The saving in weight thereby effected is of great importance, especially as the rubber tyres used for such wheels have 60 per cent. longer life than those used on steel wheels.

Hydronalium containing 90 per cent. aluminium and 10 per cent. magnesium is a much superior material than pure aluminium, especially in regard to its resistance to attack by alkalies. The present-day hydronalium is a successor to the earlier magnalium which, however, was a much less useful material. It was hitherto supposed that the resistance of a material to corroding influences was increased by homogeneity and therefore, care was taken through suitable heating to ensure the entry of the Al_3Mg_2 into the aluminium lattice. Notwithstanding this, however, distinct tension corrosion was shown, especially with magnalium. As placed on the market the alloy is a weldable material, taking a good polish. In experiments by the Deutschen Versuchsanstalt for Luftfahrt, as to the corrodibility of hydronalium in sea water, it was found that the alloy was practically unaffected.

The study of resistance to alkalis of the aluminium-magnesium alloys in which the alloying constituent—aluminium or magnesium—ranges from 2 to 15 per cent., shows that the optimum is obtained with 8 to 6 per cent.

A Still Wider Use Predicted for Nickel

Recent Contributions to the Technical Literature

WITH a view to reducing the percentage of beryllium required for the production of age-hardening in nickel- and copper-base alloys, experiments have recently been reported with alloys, containing additions of a third element, *viz.*, silver, silicon, titamium, iron, manganese, molybdenum, chromium (W. Hessenbruch, " Zeit. f. Metallkunde," Oct. 1933, p. 245), The ternary alloys are found to show equivalent hardening properties at a beryllium content considerably below that of the binary alloys; *inter alia*, examples are cited in relation to additions of molybdenum and chromium to nickel-beryllium (beryllium 1 per cent.) alloys. Marked precipitation-hardening also obtainable by means of beryllium additions to alloys of nickel-chromium base (*e.g.*, additions of 1.2 per cent. beryllium to 80/20 nickel-chromium alloy). Results of considerable practical importance have been obtained by the addition of beryllium to corrosion- and heat-resisting alloys containing nickel, chromium and molybdenum. Hardness values of a high order are obtainable and these properties are stable over a wide range of temperatures. The high-temperature tensile properties of the alloys are good and their creep strength is of a satisfactory character. Precipitation-hardening effects obtained by heat-treatment may in all cases be further raised by application of suitable cold working in association with re-heating.

Nickel Alloys at Low Temperature

The second part of an investigation on the mechanical properties of metals and alloys at low temperatures by E. W. Colbeck and W. E. MacGillivray (Institution of Chemical Engineers, Nov. 20, 1933) comprised a series of determinations, at temperatures down to −180° C., on samples of copper, nickel, aluminium, copper-nickel alloys (80/20, 55/45 and 30/70 per cent.), nickel silver (nickel 30.5, copper 55, zinc 14, per cent.), " Y " alloy, and a lead-tin solder. The copper-nickel alloys showed a constant increase of approximately 50 per cent. in tensile strength between room temperature and the temperature of liquid air, and retained their ductility down to the liquid air temperature, the elongation showing a marked improvement at the lowest temperature. The tensile strength of nickel silver also rose steadily with falling temperature, being approximately 40 per cent. higher at −180° C. than at room temperature. In this material, also, ductility was more than maintained at the lowest temperature of test. Nickel and all the nickel alloys showed appreciable increase in impact strength at sub-normal temperatures. In the course of a critical survey of the results the authors said " it is difficult to generalise on the large number of results reported, but it would appear evident that the copper-nickel alloys, 70/30 brass and nickel silver, with their excellent properties throughout the range 20° C. to −180° C., will prove valuable materials for plant to work at temperatures below zero."

Nickel Vanadium Steels

The properties of steels in which nickel and nickel plus manganese are associated with vanadium, have been recently summarised by J. Strauss ("Trans. American Foundrymen's Association," October, 1933, p. 225). Mechanical properties are cited, in the double-normalised and tempered condition, for straight nickel-vanadium steels within the limits nickel 0.75-2.11, vanadium 0.10-0.20, per cent.; additional data are suplied on the properties and uses of the most important commercial nickel-vanadium steel, containing nickel 1.5, vanadium 0.10 per cent. Both the nickel-vanadium steels and the more complex steels of which these elements form an integral part are characterised by good mechanical strength associated with exceptionally high yield point and impact strength. A supplementary table contains the properties of a number of the steels in the annealed condition. Attention is drawn to the satisfactory degree of toughness preserved by the nickel-vanadium steels at sub-normal temperatures, a property which has been utilised with advantage in railway engineering in northern countries.

In the course of investigations on the relative suitability of various alloys for use under conditions obtaining in the manufacture of sulphite pulp, a study has been made of the effect of hot sulphur dioxide gas on a series of representative high nickel-chromium alloys, on samples of nickel-copper alloys of various compositions, and on nickel-copper-silicon, nickel-iron-manganese, nickel-iron tungsten, nickel-copper-zinc, and copper-base alloys of the brass and bronze types (G. H. McGregor and J. W. Stevens, "Paper Trade J.," Nov. 2, 1933. T.A.P.P.I. Section, p. 40). The austenitic nickel-chromium-iron specimens covered various ratios of the main constituents, and also included samples containing additions of other elements, *e.g.*, manganese, tungsten, aluminium, molybdenum and copper. Test conditions comprised gas containing 17-18 per cent. sulphur dioxide, 1-2 per cent. oxygen and traces of sulphuric anhydride, at a temperature of 200° to 220° C. The results, tabulated in detail and critically grouped indicate that chromium-nickel steels of the 18/8 and 23/11 types ares highly resistant to conditions operating in pond-type sulphur dioxide coolers. Alloys of higher nickel and chromium content also proved resistant, but their physical properties render them somewhat less suitable for the type of service under consideration.

The Nickel-Plating of Zinc

The nickel plating of zinc as an underlay to chromium has been dealt with by M. de K. Thompson and F. C. Jelen (" Trans. Electrochemical Society," 1933, *63*, 141). Samples of sheet zinc plated with varying thicknesses of nickel-plus-chromium, and tested by immersion in 20 per cent. sodium chloride and 5 and 10 per cent. ammonium sulphate solutions, show that the resistance to attack is proportional to the thickness of the intermediate coating of nickel and is independent of the thickness of the chromium plating up to 0.00014 inch. The protection afforded by the nickel underlay varies with the composition of the bath from which the deposit is made; better protection is given by deposits from a bath containing sodium citrate than by those produced from a bath of the sodium sulphate type. Chromium plated over copper which is super-imposed on a thin (flash) layer of nickel (to prevent diffusion of the copper into the zinc), gives a comparatively short life, but a composite deposit, comprising a flash of nickel followed by plating with copper-plus-nickel, affords highly efficient protection under the test conditions used. The use of tin and cadmium for the intermediate layers has proved unsatisfactory; chromium plated directly on to zinc also gave poor protection.

Exports of Tin

Control Extended until 1937

AN increase in the export quota for tin from 33⅓ per cent. to 40 per cent. of the standard tonnages and the adoption of a special quota of 4 per cent. has been agreed to in London. It was announced at the International Tin Committee's meeting that the representatives of Bolivia, the Malay States, the Netherlands East Indies, Nigeria, and Siam have signed agreements for the continuance of control over production and export.

The new agreements provide for a new control scheme which does not differ essentially from the existing scheme. The scheme takes effect from January 1, 1934, and will continue for three years from that date. The agreed standard tonnages under the new scheme are: Bolivia, 46,490 long tons of metallic tin; the Malay States, 71,940 tons; the Netherlands East Indies, 36,330 tons; and Nigeria, 10,890 tons; a total of 165,650 tons.

The Governments of Bolivia, the Malay States, the Netherlands East Indies, and Nigeria have accepted the recommendation of the International Tin Committee that their export quotas as from January 1, 1934, shall be fixed at not less than 40 per cent. of the standard tonnages.

Some Recent Metallurgical Patents

Coherent Alloy Masses

THE bodies and pole-pieces of permanent or electromagnets can be made by sintering masses of powdered metal. The compressed powder is heated inductively to a sintering temperature by current in a coil of copper tubing. A suitable composition contains 5.50 per cent. of cobalt, 1.20 per cent. of tungsten, up to 5 per cent. of chromium, up to 15 per cent. of molybdenum, 0.5-7 per cent. of carbon, and the remainder iron. (See Specification No. 399,318, of Deutsche Edelstahlewerke A.G.)

Pickling Metals

A LONG-CHAIN alky quaternary ammonium compound, *i.e.*, a compound containing a quaternary ammonium grouping and an alkyl radical containing not less than 6 carbon atoms, or a solution of such a compound in hydrochloric or sulphuric acid can be added to acid pickling baths as an inhibitor. Substances referred to are octadecyl-, dodecyl-, and cetylpyridinium bromides, and cetyl- and octadecyl-trimethylammonium bromides. (See Specification No. 397,553, of Imperial Chemical Industries Ltd., A. MacArthur and A. J. Hailwood.)

Corrosion Resistant Coatings

CORROSION resistant coatings can be formed on ferrous metal articles by treating the articles with a solution containing a heavy metal phosphate or mixtures of such phosphates and also a substantial amount of a water-soluble salt of zinc or cadmium, the salt not being a phosphate and not being converted to any substantial extent into phosphate in the solution. A hot solution of approximately equal quantities of a mixture of iron and manganese phosphates and a zinc salt such as the sulphate, chloride, nitrate, or fluoride may be used. (See Specification No. 398,353, of A. Pacz.)

Hard Copper Alloys

HARD copper alloys can be made by adding to copper a hardener alloy obtained by heating together iron, aluminium, and copper to such a temperature that an exothermic reaction occurs. Other elements may be added, and the hardener may replace all or part of the tin in bronzes. The hardener may contain 10-50 per cent. of iron and aluminium. An example of a final alloy consists of 80 per cent. of copper, 1 per cent. of iron, 2 per cent. of aluminium, 13 per cent. of zinc, and 4 per cent. of tin. (See Specification No. 399,219, of N. D. Chopra.)

Annealing and Pickling

STEELS, alloy, steels and alloys containing nickel can be finished by imparting a bright surface to them, rendering the bright surface passive and then annealing at 1,650-2,000°F. for several hours in a reducing atmosphere, *e.g.*, dry hydrogen. The alloys may be washed before annealing. The surface of the steel is rendered passive by heating them in a nitric acid solution at 160-200°F. for 15-60 minutes. The process may be applied to a stainless steel containing 18 per cent. of chromium and 14 of nickel or to a nickel-chromium alloy containing 88 per cent. of nickel. (See Specification No. 399,049, of Mond Nickel Co., Ltd.)

Treatment for Metallic Surfaces

A PROTECTIVE coating can be formed on the surface of iron, zinc, magnesium, or their alloys by treating the surface with a hot acid phosphate solution containing a small amount of a metal less basic than the metal to be coated. The solution may be applied by spraying, in which case the proportion of total acid to free acid is between about 10 : 1 and 15 : 1, or it may be allowed to flow over the surface in which case the proportion is between about 10 : 1 and 12 : 1. The solution is prepared from materials of the kind described in Specification 346,401 and is then treated with an alkaline substance, *e.g.*, carbonate of zinc, manganese, or sodium, until the desired proportion of total acid to free acid is obtained. (See Specification No. 397,179, of Pyrene Co., Ltd.)

Aluminium Magnesium Alloys

ALUMINIUM magnesium alloys having enhanced resistance to corrosion and containing about 5-16 per cent. of magnesium can be made by using commercial aluminium under such conditions that they have a low content of impurity iron. Preferably the total impurity content of the aluminium used is not less than about 0.7 per cent., the impurity silicon content is equal to or greater than the impurity iron content, and the latter is not more than 0.1 per cent. A small amount of copper may be present. If necessary, the proportions of iron and silicon may be controlled by mixing commercial aluminiums of different impurity contents, or by using some aluminium of more or less high purity. (See Specification No. 398,080, of A. H. Stevens.)

Manufacture of Steel from Scrap

IN a process for manufacturing steel from steel or iron scrap such as turnings and waste ends with or without a small amount of cast iron and/or ferro-alloys, the scrap is melted in a rotary furnace utilizing pulverised solid or liquid fuels to produce a molten charge for subsequent treatment in a Martin furnace having a composition substantially equal to that of the molten charges in Martin furnaces in the known scrap process at the commencement of refining. The atmosphere in the rotary furnace may be feebly oxidising, neutral or reducing. A predetermined carbon content of the bath in the Martin furnace may be produced by adding carbon-containing substances, *e.g.*, petroleum coke, to the charge in the rotary furnace or by adjusting the burner to produce a reducing flame rich in carbon. (See Specification No. 399,796, of C. Bochicchio.)

Blowholes in Steel Ingots

Influence of Varying Oxygen and Carbon Content

THE influence of varying oxygen and carbon content in steel upon the position of blowholes in ingots was demonstrated by an exhibit of the Department of Metallurgy, University College of Swansea, at the recent Cardiff Engineering Exhibition. This exhibit consisted of a number of experimental steel ingots, cast at the College, and sectioned in order to show their internal soundness. These ingots were made during a research carried out for the Heterogeneity of Ingots Committee of the Iron and Steel Institute, and have been described in the fifth report of that Committee, recently published (price 10s.). The object of the investigation was to show the relation between different types of ingots, such as "solid," "rising," "rimming," and "box-hat" ingots, all of which were exhibited. The solid steel ingots were quite sound, and free from holes, except for a "pipe," or shrinkage cavity, large in the head but rapidly decreasing lower down the ingot. Alongside these were "rising steel" ingots, which during solidification had increased in height and become riddled with blowholes. Other examples included "rimming steel" ingots, which had a pure solid case, containing a blowhole-riddled interior. Finally there were "box-hat" ingots, which are the hollow topped; these ingots were so wild that when cast they blew out of the mould.

For structural and engineering work, cutlery, etc., steel is almost always cast solid, but large quantities of "rising" and "rimming" steel are made locally for the sheet and plate trade. "Box-hat" ingots are only made by accident. The type of ingot that will be formed is determined by the amount of carbon and oxygen which the liquid steel contains, and some data for the experimental casts was shown on the sheet of contact prints also exhibited. The ingots were so arranged that their original oxygen content increased from left to right and the carbon from top to bottom. All the experimental ingots were made from Armco ingot iron, melted in a high-frequency furnace. When molten, the steel was saturated with oxygen, and the requisite amount of carbon added as synthetic pig-iron. The final oxygen content was controlled by varying additions of aluminium, and the melt then cast.

Metallurgical Section

February 3, 1934

British Non-Ferrous Metals Research

In the second year at its London headquarters the British Non-Ferrous Metals Research Association has begun to reap full advantage of having its three main departments under one roof. Daily contact between the research, information and development staffs has reacted most favourably upon all branches of work, and in all directions the output of work has been higher than in any previous year. On the other hand, the recent unparalleled industrial depression has resulted in a reduction of income, and although this may be of a temporary nature the Association has nevertheless felt the strain of carrying out more work with lessened resources.

Research on the effect of impurities in copper, which has been in progress for some years at the National Physical Laboratory and has yielded a great fund of information on this subject, recently reached a stage demanding closer collaboration of the manufacturers in large-scale experiments. During the year good progress was made in studying macro-structure and segregation in large copper ingots, by methods comparable with those standardised for large steel ingots, and in the application of microchemical methods for identifying and studying the distribution of constituents containing impurities. The work in progress at the University of Birmingham on the production of sound aluminium ingots and castings also reached a most promising stage and is likely to result in useful practical applications. The series of researches on the corrosion of condenser tubes, taken over from the Institute of Metals some years ago, have resulted in considerable advances in the quality of this important product and have undoubtedly assisted in advancing the high reputation of British condenser tubes.

During the year further information has been gained on the factors which control the corrosion resistance of cupro-nickel and aluminium-brass tubes. For this particular investigation the Electrical Research Association has provided substantial support as some of its members are engaged in the supply of electrical power and such power stations are large users of condenser tubes. A good start has been made in the study of the factors controlling the corrosion of galvanised hot-water tanks, which is being brought into prominence due to the use of higher temperatures and generally greater severe conditions. In this connection closely related work on the testing of the quality of zinc castings and on the actual galvanising process has also made steady progress. Investigations dealing with lead and lead alloys, the improvement of tin plate (a matter of consequence to the rapidly-developing canning industry in this country), alloys for high temperature service and the electro-deposition of nickel are other directions in which considerable progress has been made.

The quickly-growing work of the development department of the British Non-Ferrous Metals Research Association has been very varied. Assistance to the many users of the Association's ternary alloys of lead has demanded much attention, for nearly 4,000 tons of the B.N.F. alloys were used during 1932 for electric cable sheathing, and their use for water pipes and other purposes is extending. The Association's wide knowledge of the properties and application of lead alloys is now proving useful in the study of tellurium lead, which is being developed by one of the Association's member companies. The value of the information service is sufficiently indicated by the large and steadily-increasing use made of it by members, whilst the Association's library, strengthened by means of a substantial grant generously provided by the Carnegie Trustees, is now, within its special field, a most serviceable collection of carefully-chosen books and periodicals.

Corrosion of Aluminium by Alkalies

The effect of addition agents on the rate of corrosion of aluminium by alkalies has already received a fair amount of investigation. Rohrig (" Chem.-Ztg.", 1923, *47*, 528) found that the addition of sodium silicate to a solution of sodium carbonate decreased the rate at which the carbonate solution attacked the aluminium, whilst the addition of sodium silicate to a solution of sodium hydroxide increased the rate of attack, especially in solutions of a moderate degree of concentration. In addition, Rohrig found that certain colloidal substances, such as glue, gelatin or agar also exhibited an inhibiting action. Still earlier Seligman and Williams (" Journ. Inst. Metals," 1922, *28*, 297) investigated the effects of sodium silicate as an addition agent in the cleaning of aluminium by alkalies, the use of the silicate as a retarder in this process having been protected by British Patent No. 127,772. A more recent investigation reported by Rhodes and Berner (" Ind. Eng. Chem.", December, 1933) has been carried out with the object of determining the rate of attack by measuring the rate at which hydrogen is formed by the reaction. It appears that the common inorganic salts of the alkali metals do not decrease the rate of action of alkalies upon the metal but actually increase the rate of corrosion. For instance, sodium chloride accelerates the corrosion to a marked degree at a concentration 0.5 mols. but decreases as the concentration rises above this value. Sodium sulphate shows a similar effect which is even more pronounced, whilst the addition of sodium phosphate increases the

rate of corrosion very greatly. Sodium metasilicate, however, was found to have a slight inhibiting action when present in rather high concentrations, but tended to cause localised pitting rather than a uniform etching. The simple aliphatic alcohols (ethyl, methyl, n-propyl, n-butyl and glycerol) showed very slight inhibiting action. A range of phenolic substances was also tested, but in no case was there any specific inhibiting action; in many cases a solution of sodium hydroxide containing a phenolic compound attacked aluminium much more rapidly than did pure sodium hydroxide of the same hydrogen ion concentration, and the general evidence pointed to increase rather than decrease in the rate of corrosion. Among other substances investigated, glucose in molar concentration was found to inhibit the action of sodium hydroxide in molar concentration almost completely, whilst gelatin had a very marked specific inhibiting effect in concentrations of 4 to 6 per cent. and this effect was in no way due to the lowering of the hydrogen ion concentration of the solution.

Corrosion of Light Metal Alloys

AT a meeting of the Royal Aeronautical Society on December 14, Dr. Aitchison emphasised the comparatively poor resistance to corrosion shown by magnesium base alloys in salt solutions. He gave some figures relating to alloys of aluminium containing additions of magnesium and drew attention to the fact that whilst magnesium alloys containing aluminium had a rather inferior corrosion resistance, those of aluminium containing up to 7 per cent. magnesium gave a very good resistance to corrosion which was probably better than that of pure aluminium, especially in the case of alkaline solutions. These alloys, said Dr. Aitchison, exhibit rapid work-hardening characteristics which were identical with those of magnesium alloys and the amount of cold work which could be put into the material was definitely limited. In the course of the discussion Dr. Karl Schmidt gave an account of the progress that had been made with magnesium alloys in Germany, and incidentally mentioned that the magnesium alloys had a remarkably interesting property in their ability to " absorb " sound. Where gear casings are made of Electron quieter running is obtained; surely this is worthy of due consideration from an industrial aspect in the ultimate aim to eliminate noise in factories.

" Pink Gold " Plating Finishes

THE issue of " Metal Industry " (New York) for December, 1933, contains a welcome contribution concerning the electrolytic deposition of " pink gold," which has recently found renewed favour in the jewellery and optical trades where it is used as an ornamental finish upon gold or gold-filled base metal, and also as a flash deposit on brass or brass-plated novelties. Mr. A. K. Pritchard, of the Continental Optical Corporation, Rochester, N.Y., who is the author of the article in question states that the " pink gold " finish has a very pleasing appearance when properly executed, and red, white and yellow may be blended harmoniously. Actually it is nearly a century ago that Roseleur first deposited pink gold by using a formula containing gold, copper and silver. Present-day practice employs nickel and palladium to replace the silver and thereby produces a deposit which is fairly resistant to tarnish. The article in question gives a basic formula for the plating solution, with detailed working directions. Deposition temperature ranges from 55° to 65° C., with a current of 3 to 6 volts. An elevation in temperature and voltage increases the rate of deposition for the nickel and palladium, whilst a decrease in temperature and voltage favours the deposition of gold and copper; this permits slight variations in the actual shades obtained.

Alloy Analysis by Spectrograph

THE application of the spectrograph to the analysis of non-ferrous metals and alloys is described in a research monograph recently published by the British Non-Ferrous Metals Research Association (price 10s. 6d.) The author, Mr. D. M. Smith, refers particularly to a systematic study of spectrographic methods which was started by the Association about eight years ago. Originally an attempt was made to provide an alternative to chemical methods for the assay of small amounts of impurities in zinc, chiefly because there was lack of agreement between the results of independent chemical analysis. The spectrographic examination of a series of prepared zinc alloys actually lead to the development of a satisfactory routine method for estimation of small quantities of cadmium varying from 0.01 to 0.001 per cent., and the method was then extended to include the estimation of lead and iron on the basis of evidence given by the same spectrum. Subsequent to this it was decided to explore the possibilities of spectrographic methods for estimating impurities in other metals and alloys of commercial importance, giving special attention to copper, tin, lead and ternary alloys of lead for cable sheathing. The experence gained by the author shows that spectrographic methods are worthy of a much wider use than they enjoy at the present moment. As stated in the foreword to this monograph, a spectrographic examination will frequently reveal in a few minutes all that the metallurgist wishes to know regarding the composition of any metal or alloy.

The Perkin Medal

Awarded to American Metallurgist

DR. COLIN G. FINK, who has been awarded the 1934 Perkin Medal of the New York Section of the Society of Chemical Industry, is in charge of the Division of Electro-Chemistry at Columbia University. This award has been made in recognition of a long list of notable contributions in metallurgy and electro-chemistry as set forth in more than ninety scientific articles and nearly sixty patents, which have marked discoveries and inventions of great value to science and industry. After completing his university work, culminating in the degree of Ph.D. at the University of Leipzig in 1907, Dr. Fink joined the research staff of the General Electric Co. and there did notable work. This included the originating of the ductile tungsten lamp filament and the copper-clad nickel-steel lead-in wire used as a substitute for platinum in lamps, radio tubes, etc. In 1917 he became the head of the new research laboratories of the Chile Exploration Co. in New York. Among his contributions there should be noted the insoluble anode " Chilex," which has been of great practical value. In 1922 he joined the staff at Columbia University, where he has devoted most of his attention to researches in electro-deposition of chromium and tungsten.

Bessemer Steel Developments at Corby

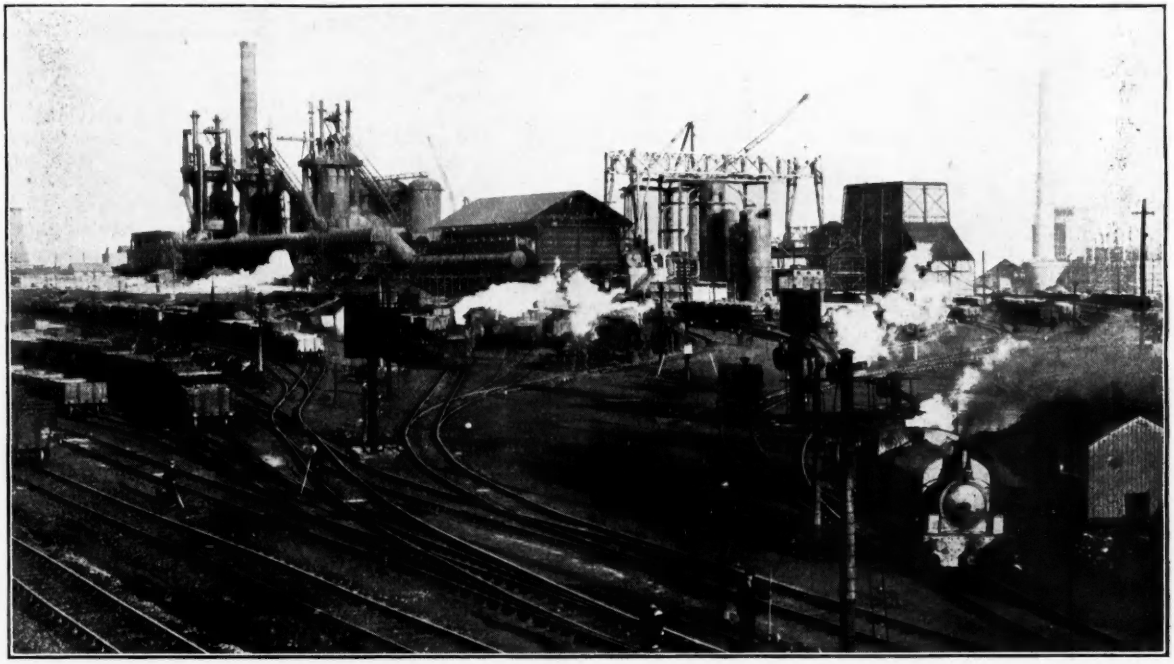

Photo: The Times

Rapid progress is being made in the development of the scheme of Stewarts and Lloyds, Ltd., for the treatment of iron ore deposits in Northamptonshire and the construction, at Corby, of works for the production of Bessemer steel. The above photograph of the new works now being erected shows, on the left, the blast-furnaces, one of which has been rebuilt on improved lines; in the centre the new ore bridge and blast-furnace gas cleaning plant; and on the right the new buildings for the by-product coking plant.

Fluxes and Slags in Non-Ferrous Foundry Practice

By THOS. TYRIE

UNTIL within recent years it was agreed that the less one added to non-ferrous metals in the melting the better were the results obtained, and that policy no doubt was perfectly sound in view of the then limited knowledge. Experience with many of the so-called fluxes, denseners, deoxidisers, etc., foisted on the unsuspecting melter enhanced the prejudice against them and it is not to be wondered at that even to-day the use of covering slags, etc., is regarded with suspicion by many. Recently, however, the subject has been dealt with upon a more logical basis, and chemical mixtures have been evolved which are in keeping with the type of alloy and the specific duty they are called upon to perform. No amount of deoxidation or reduction will correct fully, metal which is faulty due to bad melting practice and accordingly every care should be taken during the melting period. Rapid melting is ideal to prevent undue exposure to gases or air either in the early stages when the metal is likely to suffer from heavy surface oxidation or in the later stages when progressively increasing amounts of gas are likely to be absorbed. A reducing atmosphere should be avoided if gas absorption is to be prevented. It is better to have a slightly oxidising atmosphere than a reducing one.

The use of fluxes and slags in non-ferrous foundry practice was dealt with in detail by Mr. Thos. Tyrie, in a paper read before the Scottish Section of the Institute of Metals, at Glasgow, on December 11.

For convenience an arbitrary division may be drawn between deoxidisers and slags or fluxes. Many fluxes are really deoxidisers but it is preferred to consider deoxidisers as elements, either metallic or non-metallic, which are added to the bath of molten metal for the simple purpose of reducing existing oxides, any excess of the deoxidiser becoming an integral part of the resulting alloy. Fluxes, on the other hand, are chemical compounds or mixtures which combine with or dissolve undesirable solid constituents in the metal and form a slag which may be removed. The term flux is extended to include slags produced upon the surface of the metal for the purpose of protecting the melt from the atmosphere and minimising gaseous absorption. Considering deoxidants first, the ideal deoxidant would be one which is oxides but would leave none of capable of reducing existing its own oxide after deoxidising the bath. This can seldom, if ever, be attained. Attempts have been made to arrive at some conclusions as to the relative values of different elements as deoxidants from consideration of the heats of formation of their oxides, but the results so far have not been very satisfactory, due probably to the fact that values are widely different from those obtaining at the elevated temperatures of molten metal. The second consideration, namely, that the deoxidant will leave none of its own oxide in the bath implies that the new oxide be insoluble in the metal and be precipitated in fine particles throughout the liquid mass. The pure oxides of the deoxidising elements are usually solid at the temperatures employed in non-ferrous founding, but exceptions are boric oxide which melts at about 600°C. and phosphorus pentoxide which sublimes at a comparatively low temperature. It is to be expected that particles of low specific gravity will rise easily in the molten metal

but the rate of rise depends more on the size of the particle than on differences of density, which accounts for the fact that all influences tending to promote aggregation of the small grains such as stirring, contribute to their removal by flotation, and this effect within limits is more important than the actual density of the inclusions.

It is obvious that oxides which are formed in the solid state in the molten metal will not aggregate into units of any size without aid, and the deoxidation product would be better if liquid in order to ecect ready flotation. This does not mean that the oxide itself must be liquid, but rather that the oxide formed should form a fluid slag with the original oxide, which slag will rise to the surface and it is suggested this property largely effects the usefulness of the deoxidation process. Beryllium has been found highly effective for copper and gives a cast copper with a conductivity 20 per cent. better than copper deoxidised with phosphorus. A beryllium-copper alloy containing 10 per cent. beryllium has been prepared electrolytically for this work. Phosphorus, however, is probably the most universally adopted deoxidant for all copper base alloys and its action has provoked considerable discussion among authorities. With copper alone phosphorous is particularly successful, especially in view of its action in suppressing the reaction between cuprous oxide and dissolved hydrogen on solidification. The mechanism of deoxidation is assumed by many to be the formation of phosphorus pentoxide and the subsequent volatilisations of this oxide. Certainly phosphorus pentoxide is volatile at the temperature of molten copper, but the comparatively small amount of phosphorus eliminated in the reaction discounts this idea.

Objections to Use of Phosphorus

Objections to the use of phosphorus are (i) it causes the metal to penetrate the mould and thus makes dry sand almost essential. A preventative against this penetration is to coat the mould with plumbago cream made up with molasses and then to dry; (2) in yellow brass the addition of more than 1 oz. of 15 per cent. phosphor-copper per 100 lb. metal may cause porous castings and also give rise to wrinkle-like formations on the surface and occasionally on cored surfaces. Heavily phosphorised yellow metal gives off much smoke of zinc oxide on withdrawing from the furnace and the phosphorus tends to coagulate this zinc oxide which settles in fleecy masses within the mould. This causes the wrinkle formations and where evidenced the phosphorus content or addition should be reduced.

Of other deoxidants manganese is probably the most important. It is not so useful as phosphorus in that it is not able to prevent the formation of an oxide skin during pouring, and finds application mainly where the beneficial effects of manganese in the alloy are required or where residual phosphorus would be decidedly harmful. The oxide of manganese formed readily combines to give a fluid slag with other oxides present and also the silica of the crucible and is thus easily removed from the melt. Manganese reduces the fluidity of the metal and to counteract this a little phosphorus may be added unless the presence of phosphorus will be harmful. It may be mentioned that improved malleability is obtained from the use of a little manganese followed by magnesium in nickel alloys which are to be rolled or drawn, but this is rather the result of a desulphurising action than a deoxidising one, although deoxidation does accure. The manganese appears to act similarly to its action in steel, forming small globules of manganese sulphide which is less harmful than nickel sulphide and in presence of magnesium it is claimed that a very malleable metal is obtained with even as much as 0.25 per cent. sulphur present.

Metal for Pressure Castings

Silicon behaves somewhat like phosphorus and the resulting oxide forms a fluid silicate slag, but it is not satisfactory when the metal is to be used for pressure castings. Nor can silicon be used as a deoxidant in high leaded brasses as the silicon reacts with the lead forming lead silicate in the form of a voluminous grey powdery dross in the castings. Aluminium by virtue of its high affinity for oxygen would function as a splendid deoxidising metal, but for the fact that the oxide formed will neither combine readily with other oxides to form a slag, nor will it float of itself to the surface to be skimmed off. As a deoxidant it has been suggested for nickel alloys, but even then is to be avoided if the castings are for pressure work.

Passing now to fluxes and slags these are used in non-ferrous melting practice for a variety of purposes including (1) solvents for metallic oxides; (2))materials to remove inclusions other than oxygen by either mere solution or chemical reaction or mechanical action; (3) coverings to prevent oxidation or gas absorption, and (4) degasifiers.

Scientific Selection of Fluxes

Up to the present our knowledge on the subject of fluxes for non-ferrous melting has been largely empirical and it is only recently that anything has been done to establish a scientific basis for their selection. It is on account of this lack of knowledge that so large a variety of proprietary materials are actually in use and new ones are continually being boosted which so often fail to fulfil the functions claimed for them. It is obvious, however, that fluxes required for purification and protective purposes must have the power of combining with the impurities which it is desired to remove. The surface tension of the flux is of considerable importance as the interfacial tension between flux and metal determines largely the efficiency of the flux, but little is known on this point.

The field in non-ferrous practice falls naturally into two sections, (a) fluxes for high melting point metals such as copper alloys and nickel alloys, and (b) fluxes for low melting point metals such as magnesium and aluminium alloys. For the first class an enormous variety of fluxes has been suggested, many of which are quite satisfactory whilst as many are the reverse. Those materials most generally effective both as covers for protecting the metal from oxidation and as solvents for metallic oxides are the compounds of boron. Borax or boric acid owe their success to the power they possess of combining with other oxides to form a fluid slag, so fluid in some cases as to require the addition of sand for thickening prior to skimming off. Boric acid is, however, rather severe in its attack on silica crucibles and accordingly boro-calcite may be substituted for this type of work. Sodium carbonate in the crude form as soda ash is very effective in brass melting for removing acidic oxides or amphoteric oxides such as zinc oxide, and also as a desulphuriser. Potassium cyanide and potassium nitrate or saltpetre react readily, the latter being very effective in removing iron. Potassium sulphate is also found a very effective agent for removing iron and aluminium.

Removing Undesirable Impurities

A number of fluxes are available for removing undesirable impurities such as aluminium, silicon, iron, antimony, arsenic, gases, etc. The readily oxidisable materials such as aluminium or silicon may be oxidised out by the addition of an oxidising agent provided the agent is combined with a flux which will form a fluid slag with the resulting oxides and so clear the metal. Thus aluminium may be removed from brass by the use of barium sulphate; 16—20 per cent. of the sulphate is required for 1 per cent. of aluminium and the metal must be superheated to about 1,320°C. This high temperature is necessary as only at a high temperature is the oxygen liberated from the sulphate to oxidise the aluminium. Barium sulphide is formed, but the sulphur is too firmly held to do harm and ultimately unites with the aluminium oxide to form a skum easily skimmed off. The appearance of the surface of the metal forms a guide as to when the reaction is complete, as when the skimmer is drawn over it the surface appears oily if aluminium is present and the zinc oxide smoke is not freely evolved; when free of aluminium on the other hand the metal surface appears wrinkled and zinc smoke is freely evolved.

This use of oxidising agents in combination with a suitable flux has been extended considerably and materials prepared which are capable of carrying out a great variety of scavenger work. Peroxides of the alkalis, alkaline earths especially barium peroxide, barium carbonate, red lead, lead dioxide, manganese dioxide, cupric oxide, etc., or their salts as plumbates, manganates, chromates, etc, are used in combination and with soda ash as a flux. Barium peroxide may

be used for removing aluminium and antimony when present in turnings, cuttings, etc., *i.e.*, in the free state. The peroxide evolves its oxygen at low temperatures and the unalloyed impurities are oxidised before the actual bath of metal melts. The aluminium and antimony oxides formed combine with the soda ash added to form aluminates and antimonates which slag out. Both barium peroxide and barium carbonate find use as removers of sulphur dioxide and carbon monoxide which become bound as barium sulphate and carbonate. It is also well known that cupric oxide removes hydrogen and in a lesser degree acts as a scavenger for oxidising the low vapour pressure metals aluminium, arsenic, antimony and zinc.

For metals of lower melting point or the aluminium and magnesium alloys the choice of suitable fluxes is rather limited. The removal of aluminium oxide from heats of pure metal or its alloys is very difficult to accomplish owing to the comparatively inert nature of the oxide and its similarity in density to that of the parent metal. Up to the present no satisfactory deoxidiser has been found and consequently the removal of aluminium oxide is dependent entirely upon solution processes. The active agent in the fluxes used is a fluoride, generally one or other of the alkali fluorides or a double fluoride such as cryolite. An objection to the use of fluorides is that they attack the crucible badly and cause the introduction of elements into the melt which are undesirable.

Several of the substances regarded as fluxes for these alloys depend rather upon their ability to produce flotation of the oxide than upon any solvent action, and may therefore be regarded as mechanical in their behaviour. Such substances must be gaseous at the temperature of the bath and without chemical action on the metal itself. Zinc chloride behaves thus, but its use must be regarded as very limited in view of its hygroscopic nature and the detrimental effect of moisture on aluminium and its alloys. For this reason the double chloride zinc ammonium chloride is preferable, as this salt can be readily prepared and does not absorb moisture. Ammonium chloride itself is a very efficient medium and probably the most suitable by virtue of its safety and ease in use.

Treatment with chlorine and nitrogen has been tried for removing dissolved gases and although not truly fluxes their use is interesting. Chlorine combines readily with aluminium forming volatile aluminium chloride. The removal of dissolved gases by chlorine will thus depend upon its chemical activity and the scavenging action of the aluminium chloride formed. The mechanism of the removal of dissolved gases by nitrogen is surmised to be one of a scavenging nature in which the dissolved gases diffuse into the nitrogen bubbles and are carried away.

The Recovery of Zinc from Scrap and Dross

Precautions Necessary to Avoid Loss by Oxidation

GALVANISERS usually accumulate a collection of different forms of waste zinc residues. The larger firms instal furnaces so that the metal may be recovered, but the smaller firms are often content to sell such accumulations. The makers of different mechanically-worked zinc products also have waste material in the form of skimmings, shavings, fine dust, etc. In addition there are ashes and dross recovered from zinc scrap which has been melted down and skimmed.

The usual distillation process for zinc is seldom applied to these waste products, and the most satisfactory treatment consists of liquating or sweating the easily fusible metal, which is subsequently refined. Ashes which remain are then subjected to a wet process, but this process is economical only when the market price of zinc stands at a comparatively high figure.

The Presence of Chlorine

Prior to commencing the sweating process it is customary to ascertain if the ashes or dross to be treated contain chlorine. The reason for this is that chlorine compounds are used as a flux for the zinc, and also to ensure the surface of the molten metal being bright and clear for any dipping of iron articles. Chlorine is an objectionable impurity in the eyes of the metal refiner, and as a rule, it is customary for a deduction to be made from the price offered because of this constituent being present. The usual practice is to thoroughly wash all ashes which contain chlorine compounds. In this way the possibility of unduly heavy volatilisation losses being encountered are largely obviated. Washing is usually performed in a large open tank, and the suspected scrap and dross is simply stirred up in water.

Scrap and dross treated in this way require to be dried prior to introducing to the liquation hearth. The sweating is applied alike to drosses, skimmings, and other forms of ashes so long as they show evidence of much metallic matter. The furnaces hearth is built of firebrick with fireclay rammed on the surface, but the bed does not require to be of the same thickness as is necessary in general reverberatory furnaces, as there is less opportunity offered for the molten metal to penetrate the refractory material. The first part of the treatment is similar to the general liquation of easily fusible metals. The zinc drosses are mixed with small coal, the amount added being dependent on the proportion of metallic zinc present. The proportion of coal used is generally greater than that required for tin residues. Besides small coal, grease wastes, cheap oil, and any other waste carbonaceous matter is added, and the mass well mixed by shovelling.

The furnace is heated to the required degree before charging the dross. In some cases it is considered advisable to raise the temperature above that actually required, and then allow the cold charge to bring this down to the desired degree. The mass is spread over the bed of the hearth in a fine even layer, the firebars are kept well together, and the charging doors only opened when fresh additions require to be made. In this way the oxidation of the zinc is kept down to a minimum. A record is generally kept of the time and conditions best suited for the working of each particular type of different residue. As an example of this, the chimney draught is noted, the composition of the coal used, and the position of the firebars and damper. These same conditions are then used with precision on a succeeeding lot of material, and sound control is thus established. If these practical details are not followed, the result is that undue volatilisation losses are suffered, which otherwise would have been available.

With the latest oil-fired liquation hearths, however, these safeguards are not so forceably required as the oil is introduced by an oil pump working at a definite pressure as registered on a gauge for the purpose, and the manipulation of firebars, dampers, etc., is unnecessary.

Furnace Conditions

Great care must be taken in all cases that a genuine reducing flame is maintained, so that the atmosphere in the furnace is completely reducing. Neither the sweating of tin or lead ashes, in any of their forms require this point to be so rigidly followed. Zinc has a much greater affinity for oxygen than that possessed by either tin or lead, and is much more readily caused to ignite and burn freely. When coal ashes require to be removed, this is done by " keying " so that no air is admitted to the working hearth. In large zinc smelting works, all the zinc fume which is evolved is collected in specially constructed condensers and fume-recovery plant, but in the recovery of zinc from waste residue, no such elaborate arrangements are employed. The smaller metal refiners depend on their skill in preventing the formation of temperatures which would cause the zinc to burn and volatilise. Once a small section of the charge has become unduly heated so that ignition of the metal occurs, the flame rapidly spreads across the hearth until a sufficiency of oxide of zinc has

exerted its insulating influence. Where the draught is such that the oxide does not get the opportunity to deposit, that particular section of the zinc may remain ignited for a number of minutes, and constitute an appreciable loss.

No fluxes have need to be used in this work, and no slags are produced. The metallic zinc present in the dross melts and runs down the sloping bed of the hearth, eventually collecting in a well at the far end of the furnace. This differs slightly in construction from that used for the working of tin or lead residues, as the molten zinc must be given no opportunity to volatilise whilst accumulating in the molten condition. One furnace design was so constructed that the zinc was caused to flow from the well in a thin clean stream to covered ladles or covered moulds. The remainder of the molten zinc which was covered by a thin skin of oxide was allowed to form a constant level in the well. A little tallow or grease waste is used as a protecting cover for the latter so that the amount of zinc oxidised at this point is reduced to a minimum, but one zinc refiner prefers to cover the metal in the well with a mixture of zinc ashes and fine coal. This protected the surface, but on eventually skimming the latter, if anything, a bigger proportion of dross was finally removed.

Where possible, the heated mass on the sloping hearth should be raked about as seldom as possible, and when all metal appears to have been sweated out, a fresh heap of dross is charged. This differs from the sweating of tin or lead drosses, where it is customary to rake the charge frequently to ensure all molten globules being extricated from the mass of the ashes. The residual ashes are allowed to remain in the furnace until the refining of the zinc has been completed. In some cases no refining is attempted, and the metal is sold as crude spelter.

Instead of allowing the molten metal to be run directly into moulds, it is a more profitable operation to refine the product. In the ordinary way, the metal in the well is allowed to settle, when it separates into three layers. As lead is almost invariably present, this being the heavier metal, sinks and lies at the bottom of the mass; zinc containing iron is deposited next in the form of a zinc-iron alloy. Whilst the purer zinc rises and forms the topmost layer. The lighter class of impurities rise to the surface of the pure zinc and are skimmed off. These contain a portion of zinc oxide which has been inadvertently formed, and also a small amount of metallic zinc; such skimmings are accumulated and re-worked at frequent intervals by themselves.

In most cases, the zinc is removed from the top layers (by hand-ladles) into square moulds. The ladling of the purer zinc is continued until the zinc-iron layer has been reached. This is found by inserting iron rods which are coated with specially prepared enamels, and so develop different colours as a result of coming in contact with the metals as found in the three different layers. After ladling off as much pure zinc from the surface as possible, the increased quantity of hard zinc and leady zinc are then dealt with. A tap-hole at the bottom of the well allows the heavier lead to be drawn off, after which the hole is "plugged" with moist fireclay.

The hard zinc thus recovered from waste drosses and skimmings is liable to contain numerous impurities seldom encountered in the ordinary classes of zinc. Arsenic and antimony are sometimes present to some extent, and this gave rise to investigations in order to ascertain the reason for their appearance. Of the modern methods of eliminating arsenic and antimony in such small proportions, use has been made of the magnesium chloride process, and also the aluminium process. Both of these methods are effective, but the aluminimum process has given rise to poisoning cases due to the aluminium arsenide being wetted whilst in heated condition, and thus evolving arsenetted hydrogen. The zinc thus obtained is suitable for most commercial purposes.

Recent Metallurgical Patents

High Conductivity Copper

COPPER of high conductivity can be obtained by melting copper containing calcium, barium, strontium, or magnesium which has been added as a deoxidiser, and passing a substantially inert gas through the melt to remove partially, or completely, the excess of the deoxidiser. Hydrogen, nitrogen, or ammonia may be used as an inert gas and may be preheated. The melt may be mechanically agitated. (See Specification No. 401,008, of Roessler and Hasslacher Chemical Co.).

Fluxes for Soft Soldering

A FLUX for soft soldering stainless steels, zinc, copper, brass, bronzes, and other metals may comprise a mixture of orthophosphoric acid and a basic substance which can be vaporised without decomposition, for example ammonia, aniline, pyridine, or toluidine. The proportions used are such that an excess of acid or base is present in the mixture after the resulting phosphate has been formed. For example, aniline and orthophosphoric acid may be mixed to form a flux containing an organic phosphate or a mixture of such phosphates, the flux being used in powder form or mixed with glycol, aniline, water, or other inert substance to form a paste or solution. (See Specification No. 400,609 of H. Sutton and J. W. W. Willstrop).

Refining Metals and Alloys

A POWDER for refining lead, tin, or alloy of lead and tin with or without antimony may comprise 37 parts pure finely powdered chloride, 14 parts common salt, 11 parts calcium chloride, 14 parts common salt, 11 parts calcium chloride, 25 parts carbon, and 14 parts pure naphthalene, the parts being by volume. The carbon is preferably inert animal carbon or other inert carbon such as lampblack or gas carbon black. The powder is mixed with the metal at a temperature between 300-750°F. and is useful for refining Sh-Sb-Pb alloys. (See Specification No. 400,258 of I. Hall.)

Institute of Metals

Annual General Meeting

THE twenty-sixth annual general meeting of the Institute of Metals will be held at the Hall of the Institution of Mechanical Engineers, Westminster, S.W.1, on March 7 and 8.

On Wednesday, March 7, the following papers will be presented:—"Minimum Dimensions of Test Samples for Brinell and Diamond Pyramid Hardness Test," (G. A. Hankins, D.Sc. and C. E. Aldous, B.Sc.); "Note on the Influence of Gases in an 8 per cent. Copper-Aluminium Alloy on Normal and Inverse Segregation," (I. G. Slater, M.Sc., Ph.D.); "Diffusion of Zinc and Iron at Temperatures below the Melting Point of Zinc," (G. Rigg); "Influence of the Intercrystalline Boundary on Fatigue Characteristics," (H. J. Gough, D.Sc., H. L. Cox, B.A., and D. G. Sopwith, B.Sc.Tech.); "The Viscous Properties of Extruded Eutectic Alloys of Lead-Tin and Bismuth-Tin," (C. E. Pearson, M.Met.); "A Note on Some Formulæ concerning Viscous and Plastic Flow in Soft Metals,"(E. W. Fell, M.Sc.); "Castability of Ternary Alloys," (Professor A. Portevin and P. Bastien).

Annual Dinner and Dance

The annual dinner and dance will be held at the Trocadero Restaurant, Piccadilly Circus, W.1, on Wednesday, March 7, at 7 p.m. The price of tickets, exclusive of wines, is 15s.

On Thursday, March 8, the following papers will be presented:—"Alloys of Silver and Beryllium," (H. A. Sloman); "Transverse Tests on Sand Cast Aluminium Bars," (C. E. Phillips and J. D. Grogan); "The Constitution of Copper-Iron-Silicon Alloys," (Professor D. Hanson, D.Sc., and E. G. West, Ph.D.); "Transformations in the Copper-Palladium Alloys," (R. Taylor, B.Sc.); "The Malleability of Nickel and Monel Metal," (O. W. Ellis, M.Sc.); "The Constitution of the Alloys of Magnesium in Nickel," (J. L. Haughton, D.Sc., and R. J. M. Payne, B.Sc.).

A visit will be made to the Post Office Engineering Research Station, Dollis Hill, London, N.W.2, on Thursday, March 8, at 2 p.m.

Metallurgical Section

March 3, 1934

Corrosion Resistance and Mechanical Strength in Aluminium Alloys

SOME of the lines of research which are being followed in the attempt to produce aluminium and aluminium alloys with the highest possible resistance to corrosion, were outlined by Mr. N. D. Pullen, in a paper read before the Sheffield Section of the Institute of Metals, in January. He pointed out that the first step was to eliminate impurities which are known to have a definite deleterious action; alternatively, reduce these impurities to the smallest possible amount. Commercial aluminium contains varying proportions of iron and silicon as the chief impurities, and the influence of these elements is still under investigation. It would seem to be generally accepted that the iron content should exceed the silicon content, but to what extent this should be so has not been decided. The influence of silicon alone is a matter for consideration in regard to heat treatment. Some workers in Germany maintain that free silicon should be entirely absent if the maximum degree of incorrodibility is to be attained; in other words, the metal should receive heat treatment to the requisite amount and of the nature required for all the silicon to be taken into solid solution. The copper content should be kept to a minimum of the order of 0.01 per cent.

Corrosion in aluminium may be one of three types. The commonest form is the irregular formation of pits, with or without deposits of corrosion products around them. In one case these pits may be quite small and of little consequence; in another case they may be far less numerous but relatively large and possibly deep. The third type is seen mainly in alloys where certain constituents are prone to form on crystal boundaries; in this cases there is intercrystalline corrosion of a dangerous type which may pass unnoticed until the metal fails or fractures.

The amount of heat treatment which the alloy may profitably receive depends upon the relative importance of corrosion resistance and mechanical strength, for it often happens that a heat treatment which will give the desired corrosion resistance may not give the desired tensile strength or vice versa. For instance, those aluminium alloys which contain magnesium and silicon, of the order of 0.75 per cent. in each case, are particularly susceptible to heat treatment. Carried out in two stages, the aim is to take the whole of the magnesium silicide into solid solution and then bring part of it out of solution. The second stage in the heat treatment, *viz.*, the so-called " accelerated ageing," may improve the mechanical properties of the material but may not improve its corrosion resisting properties, and ultimately corrosion may come into evidence along the crystal boundaries where certain constituents have segregated. In those cases where mechanical properties are only a secondary consideration, some protection has been afforded by the addition of alloying elements which are capable of forming insoluble basic salts, a typical example being the presence of antimony in one particular German alloy ("Seawasser"), which, in contact with salt water, suffers a certain amount of initial corrosion when the antimony forms an insoluble basic antimony oxychloride on the surface of the metal and so tends to prevent further action.

An entirely different method of attacking the problem of good mechanical strength combined with corrosion resistance has been achieved in the maufacture of " Alclad," which is a composite sheet having thin outer layers of high-purity aluminium, with a core of Duralumin alloy to give mechanical strength. This product is said to have the very useful property of being (to some extent) self-healing, for if the aluminium skin becomes broken a protective influence is exerted if the damaged area is not too great in extent.

Vacuum Furnaces for Metal Melting

IT is well known that the purity of metallurgical products may be adversely influenced by the reactions which take place between the hot furnace charge and the atmospheric gases. In one case there may be a simple mechanical absorption of gas bubbles; in another case there may be liquid and solid solution; in a third case, some definite chemical reaction with one or more of the ingredients of the charge. The complexity of the problems need not be detailed, for the subject of " gases in metals " has been dealt with on several occasions during the last two or three years, especially at the symposiums held by the American Institute of Mining and Mechanical Engineers. Writing in the January issue of " Metals and Alloys," Mr. N. A. Ziegler, of the Westinghouse Research Laboratories, East Pittsburgh, is therefore fully justified in advocating the adoption of vacuum furnaces in metallurgy. He points out that the high frequency electric furnace, which would be used in vacuum processes, has now become a commercial proposition in certain directions. According to Dr. W. J. P. Rohn (" Journ. Inst. Metals," 1929, *42*, 203) the only satisfactory method for the complete elimination of shrinkage cavities and blow-holes in high grade metals and alloys is to be sought in melting and casting them in a sufficiently high vacuum. The development of vacuum melting, moreover, is justified by the fact that alloys which are properly prepared in vacuum possess certain

properties which cannot be obtained by any other means. For example, Mr. Ziegler points out that 4 per cent. silicon-iron alloys prepared in a sufficiently high vacuum have higher purity and consequently higher magnetic properties than similiar alloys which have even been melted in a hydrogen atmosphere. In addition, some alloys which are very difficult to make under ordinary conditions, such as 8 per cent. aluminium-iron, are easily prepared in vacuum. To cite another instance of the advantage of vacuum furnaces, it may be mentioned that electrolytic nickel is too brittle for any practical use when melted in air without any deoxidiser, but the same electrolytic nickel, melted in vacuum, can be forged to thin rods and ultimately drawn to wire. Vacuum-melted electrolytic copper does not contain any oxygen, and for this reason it is never sensitive to hydrogen embrittlement. In view of the ever-growing demand for high quality alloys, Mr. Ziegler is of the opinion that the vacuum furnace is now passing from the laboratory to the commercial stage. Between 25 and 30 years ago the electric furnace was in a similar position.

Chromium Plating Equipment

THE use of chromium plating continues to increase and the demand for plating equipment during the past year has been very large. Evidence of this is to be found among the exhibits at the Birmingham Section of the British Industries Fair, where chrome plating apparatus continues to attract attention. The operating principle of one particular machine is semi-automatic, for articles to be plated are carried once around the plating vat at a speed which is determined by the required period of deposition. The vat is surrounded by a water-jacket for heating purposes, and fume exhaust ducting and an expansion chamber are also embodied in the plant. Fully-automatic plating plants, comprising all the vats necessary for the complete process, have been still further improved. A plating barrel which was shown for the first time last year, is now obtainable in two larger sizes. An improvement in standard barrels of the closed type is also exhibited, with stoneware in place of lead-lined wood (or iron) vats; this new barrel ensures freedom from current leakage. A new gas heater provides a convenient and quick method of heating plating solutions, and is claimed to warm a nickel plating vat for a few shillings per week. Two round rod and tube polishing machines are also shown, both of the centreless type, one with a vertical abrasive band, the other with horizontal wheels; it is claimed that skilled labour is not essential for either machine.

The Iron and Steel Industry

A SPECIAL meeting of the National Federation of Iron and Steel Manufacturers was held in London on February 22 to consider the reorganisation scheme drawn up by the Joint National Committee. Protective duties expire on October 25, and if by that date the industry is not put in order in a way that will secure approval it is threatened that the duties may not be renewed. As a result of the discussions the Federation decided to accept in principle the resolutions of the constitution in the general terms of the printed draft circulated to members on January 4, but directed that a committee be appointed to prepare a final draft constitution to give effect to amendments suggested by counsel and to take into consideration suggestions for amendments which have already been received or may arise before March 8 next. The final draft is to be submitted to another special general meeting of the Federation on April 19. The scheme which has now been broadly approved is believed to correspond with one of those drafted some months ago by the reorganisation committee presided over by Mr. Charles Mitchell, chairman of Dorman, Long and Co.

Under this scheme the powers of the National Federation would be widely extended; it would be granted a Royal Charter, and would become a corporation representing the entire iron and steel industry. This corporation would possess what have been described as persuasive powers to co-ordinate the activities of the various sectional associations within the industry, but no compulsory powers as regards amalgamation or price-fixing are suggested. The general part of the scheme is understood to provide for the manufacture of pig iron (including ferro or spiegel), wrought iron and steel (including crucible and electric steel), the manipulation of the latter groups by cogging, forging, drawing or rolling into semi-finished or finished material; and such other operations in the production and manipulation of iron and steel as may from time to time be approved by the members of the Federation. Other objects are to provide services of an advisory character for the assistance of its members and affiliated associations, such as statistics, trade intelligence with regard to home and foreign markets and transport facilities, propaganda and guidance on employment, financial, technical, legal, and other matters.

Selecting Alloy Steels

THE difficult problem of selecting alloy steels is discussed by Mr. H. W. McQuaid, in a recent issue of "Blast Furnace and Steel Plant," and he points out that it is not a simple matter. The fact that metallurgical laboratories are unable to agree as to the most satisfactory steel for a given duty indicates that there is little to choose between many of the steels available, and that any particular differences can only be determined by large scale investigation. A careful study must be made of every step in the ultimate processing and working of the steel, and at the same time knowledge is required regarding the effect of a given alloy or combination of alloys on the reaction of the part to any of the steps in processing. For instance, high nickel-chromium or nickel-chromium-molybdenum combinations must be handled carefully in the blooming mill, and in rolling, to prevent internal ruptures on cooling. Some of the alloy steels, particularly those high in nickel, tend to harden in air, so that a very careful annealing is also necessary. The effect of carbon in combination with the higher percentages of alloys must also be carefully studied, where machinability is of primary importance. Alloy steels which are sufficiently low in carbon and alloy to require water quenching, are especially subject to distortion, so that if absence of distortion is the primary requisite, oil hardening steels are required. This subject of distortion is of utmost commercial importance and its reduction to a minimum is one which can only be accomplished by close co-operation between steel user and steel maker.

The Industrial Application of Copper and Its Alloys

By J. W. DONALDSON, D.Sc.

Developments in the refining and purification of copper are discussed in the February issue of "Metallurgia," from which this article is reprinted. The author gives special attention to the increasing importance of certain copper alloys and to recent developments in special alloys.

INVESTIGATIONS on the influence of impurities on copper have not only been made on an industrial scale with the view to improving copper for practical applications and for alloying, but they have also been carried out in the laboratory in order to determine the influence which very small quantities of such impurities have on the metal. The experiments have not only been conducted on electrolytic copper of a high degree of purity, such as is used for electrical purposes and high grade alloys, but work has also been done on "best select" or fire-refined copper which is used very extensively in industry.

An example of the first type of investigation is the production on an industrial scale of oxygen-free copper of high conductivity. This has been achieved not by the use of deoxidisers but by keeping the metal free from oxygen during the smelting process, and protecting it from oxidation during melting and casting. The ductility of oxygen-free copper in the form of hard-drawn and soft-annealed wire respectively is stated to be 80 and 85 per cent., as compared with 50 and 75 per cent. for ordinary electrolytic copper. It is also interesting to note in the preparation of copper alloys containing zinc that high-purity zinc has been prepared on an industrial scale by the New Jersey Zinc Co.

The influence of impurities on copper has formed the subject of a series of important researches carried out at the National Physical Laboratory for the British Non-Ferrous Metals Research Association. In these investigations, which were made on fire-refined copper, consideration has been given to the presence of bismuth, and how far its injurious properties can be neutralised by the presence of oxygen or by the combination of oxygen and arsenic or oxygen and antimony. As a result of these experiments, it has been clearly shown that bismuth, in amounts which would be injurious if present alone, is neutralised by the above combinations, and that in the absence of oxygen appreciable quantities of either arsenic or antimony are necessary to neutralise the deleterious effects of bismuth. If similar results can be produced on a large scale, these researches will have a very important influence on the industrial applications of copper, since the bismuth content affects not only the use but also the buying and selling of many thousands of tons of copper annually.

The welding of non-ferrous metals usually presents more serious difficulties than are encountered in the welding of steel, and consequently has not had the same practical applications. During recent years, however, the welding of copper has been practised with a considerable degree of success, and improvements are to be noted both in technique and practical developments.

When compared with steel, copper possesses a very much higher thermal conductivity, and consequently a higher welding temperature is necessary. It is claimed that this high temperature is best obtained by use of the electric arc, by which a more intense local heat is obtained than when using the oxy-acetylene flame. The temperature obtained by either method, however, is not sufficient for good welding, and a certain amount of preheating is necessary. By using the electric arc greater speed of deposition is obtained, and there is a freedom from contamination by gas products, which is of extreme importance, as the presence of such impurities, particularly of oxides, leads to porosity and defective welds. It is stated that the presence of 0.01 per cent. of oxide in copper is sufficient to produce trouble. In addition to technique, the welding of copper has been made of practical importance by the use of properly deoxidised copper. To prevent oxidation, coated electrodes are used, having approximately the same melting point as copper, and usually containing 0.5 per cent. of silver.

A Battery of Ajax-Wyatt Brass Melting Furnaces (The Electric Furnace Co.)

With properly deoxidised copper, suitable electrodes and proper manipulation, very satisfactory results are now obtained, particularly when copper is welded in a horizontal position. Such welding has been principally applied to the construction of locomotive fire-boxes, and to a lesser extent in the manufacture of copper vessels for certain industrial processes, and in the repair of such vessels.

The use of copper in the pure state is still principally confined to the electrical industries, at least 40 to 50 per cent. of the copper produced annually being used for such purposes. There are indications, however, that copper is being used to replace other metals, alloys, and materials for a variety

of purposes. During the last few years, owing to its low price, copper pipes have been increasingly used to replace iron and lead service pipes. A considerably longer life is obtained from such pipes, which largely compensates the extra cost, and the use of copper for such purposes is likely to increase in the future.

Alloys for Condenser Tubes

The alloys of copper and nickel containing from 20 to 30 per cent. of nickel, and generally spoken of as the cupro-nickel alloys, have during recent years been used in increasing quantities industrially for condenser tubes, both for marine purposes and for land plant. The cost of such tubes are undoubtedly high, when compared with 70 : 30 brass tubes, but their resistance to corrosion gives them a longer life and definitely reduces condenser troubles, and thereby more than compensates for the increased initial cost.

During the last ten years cupro-nickel condenser tubes have been fitted in ships sailing over practically all the sea routes of the world, and have withstood successfully —the various kinds of water to which they have been subjected. Such tubes have been fitted not only in the British, American and continental navies, but also in all the large mercantile fleets. As an example of the confidence which such tubes have inspired, is the recent statement that, in the new cruiser and six destroyers for the United States Navy, 330,000 lb. of cupra-nickel condenser tubes, having a composition of 75 per cent. copper, 20 per cent. nickel, 5 per cent. zinc, are to be fitted. Another alloy which is being used for condenser tubes is the alloy developed by the British Non-ferrous Metals Research Association, and known as aluminium brass. This alloy contains approximately 76 per cent. copper, 22 per cent. zinc, and 2 per cent. aluminium, is strong and ductile, has a high resistance to corrosion, and good film-forming properties. It has become of industrial importance, due largely to improvement in foundry technique, resulting from the introduction of the Durville method of casting.

High-Duty Copper Alloys

A development in the production of high-duty copper alloys during the last few years, and one which has very marked effects on their properties, is the introduction of small amounts of nickel to such alloys. In rolling-mill brasses, which contain a high percentage of lead, a small addition of nickel not only produces a better distribution of the lead, but also increases the toughness. Nickel bronzes containing 5 per cent. nickel and 10 per cent. lead have also been found to be very suitable for high-speed parts, working in contact with hard nitrided steel.

An alloy containing 80 per cent. copper, 10 per cent. tin, and 10 per cent. nickel has also been recommended, and has given satisfaction for such parts as pump liners and slide valves, working with a reciprocating motion and where a fair degree of hardness is necessary. The addition of nickel to high-tensile brass in quantities varying from 2 to 2.5 per cent. has also been found to be beneficial by increasing the ductility of the alloy and also its resistance to erosion. Industrial applications of high-tensile brass containing nickel are its use for marine propellers, turbine impellers in hydro-electric plant, and highly stressed electrical castings where non-magnetic properties are desirable, as well as strength and resistance to corrosion.

Aluminium Bronzes

A series of copper alloys which have become of increasing importance are the alloys of copper and aluminium. These alloys, generally known as the aluminium bronzes, have been known for a considerable time, but have not been generally used for engineering purposes until recent years. This was largely due to the fact that apart from small die castings, it was very difficult to obtain sand castings of such alloys. The tensile properties of the aluminium bronzes were also unsatisfactory, particularly the yield-point.

As a result of progress in foundry technique and the slow and steady filling of moulds by the Durville process already referred to, it has become possible to obtain sound castings and ingots of these alloys. Such ingots can be rolled, drawn, forged, or extruded without any detrimental results, as a result of the absence of aluminium oxide and shrinkage and gas cavities. The mechanical properties have also been improved by selecting suitable proportions of aluminium for the different purposes for which the alloys are intended, whether they are to be used for forging, heat-treatment, or wire-drawing, and by the addition of other elements, such as nickel or iron or both in small proportions. The addition of 4 to 7 per cent. of nickel to an aluminium bronze has a marked influence on the yield-point, breaking stress, and ductility. Resistance to fatigue and alternating stress are also considerably improved by such addition, and the strength at high temperatures is improved and maintained.

The result of such foundry treatment and alloy additions is that aluminium bronzes are now being used on some large scale applications, where hitherto they were only used in the manufacture of small die castings. Modifications of their properties by nickel also increases the density, and renders the alloy especially suitable for pressure work, with the result that their use is increasing in equipment working under severe hydraulic pressures.

Special Copper Alloys

A series of alloys on which a large amount of work has been done during the last year or two, particularly in Germany, are the alloys of copper and beryllium. When beryllium is added to copper, usually in the form of a 10 per cent. copper-beryllium alloy, in amount varying from 2 to 2.75 per cent., a series of alloys is obtained, which, on heat-treatment and age-hardening, have remarkable properties both as regards strength and hardness. Copper containing 2.5 per cent. beryllium, when annealed at 800°C. and quenched in water, then age-hardened at 250° to 300°C. for varying periods, has a tensile strength varying from 65 to 80 tons per sq. in., and a Brinell hardness of 350 to 400. Good castings are obtained from such alloys, free from porosity, and they have a high electrical conductivity.

So far there have been few practical applications for the copper-beryllium alloys, principally due to the high price of beryllium, but, in Germany, attempts are being made to use them for industrial purposes. The copper-beryllium alloy just mentioned is stated to be particularly suitable for the manufacture of springs, both in spiral and laminated form, as it is non-magnetic, less liable to break than steel, and does not corrode. Interesting investigations have also been carried out on the age-hardening or precipitation-hardening of copper-nickel-aluminium alloys which have also shown susceptibility to such treatment, and two interesting papers on these alloys were read at the recent autumn meeting of the Institute of Metals.

Recent developments resulting from the successful mechanical working of hard and brittle alloys are the production of wrought articles from an 8 per cent. phosphor-copper alloy, as the result of investigations carried out in Germany and also in this country. The articles produced include rods, tubing, sheets, cooling worms, and pump parts, and are stated to be hard and strong, resistant to shock, and to machine well. It has also been indicated by the German investigators that there is a possibility of working successfully other brittle alloys of copper—namely, those with arsenic, antimony and silicon. In this country a copper-silicon alloy containing 3 to 4 per cent. silicon with or without 2 per cent. iron has been in use for some time, both in the form of castings and also in the worked condition, and has replaced gunmetal and high-tensile brass for many parts.

British Cast Iron Research Association

ACCORDING to the "Bulletin of the British Cast Iron Research Association" for January, the total number of balanced blast cupolas now in operation, or under construction, has reached fifty, thirty-seven in operation and thirteen under construction, the aggregate tonnage output being 334 tons per hour. The experimental cupola, 24 in. internal diameter, balanced blast type, is reported to be under construction and will shortly be erected. The long awaited report on methods of testing foundry moulding sands, being the new edition of Research Report No. 73, will be circulated to members as soon as it is available and a lengthy report on core sands is also nearly ready for issue.

Rhodium Plating

A New British Development

RECOGNISING the possibilities of a practical process for electro-plating with rhodium, Johnson Matthey and Co., Ltd., have recently developed a new process, which, after exhaustive tests and trials of all descriptions, has proved to be of remarkable merit and a distinct advance upon competitive plating processes.

Rhodium plate as obtained by the J.M.C. process is (1) stainless and untarnishable, (2) white, (3) very hard and durable, (4) practically non-porous, and (5) moderate in cost. It is particularly suited to silver, silver-plate, nickel, nickel-plate, nickel-silver, copper, brass and bronze, but is primarily intended for obtaining an untarnishable finish on silver and silver-plate. Being a precious metal rhodium plate does *not* debase silver, and may therefore be applied to hall-marked silver. The appearance is handsome and the colour approximates so closely to that of silver that an expert eye is required to distinguish any difference. Moreover, owing to the extraordinary efficiency of the plating process it is found that the very thinnest and lightest deposits are quite satisfactory in preventing tarnish and consequently in spite of the actual costliness of rhodium metal the cost of rhodium plate is quite moderate. In order that those interested may judge the merits of the process for themselves Johnson Matthey and Co., Ltd., have installed a demonstration plant at their Hatton Garden works.

New Copper Alloys

Hardening by Heat Treatment

A SERIES of new copper alloys has been recently perfected at the laboratories of I.C.I. Metals, Ltd. The remarkable feature of these alloys is that by simple heat-treatment their hardness, strength and other mechanical properties can be considerably improved. Other copper alloys, as a rule, soften under heat and can be hardened only by cold working; the most notable exception, beryllium, is too expensive for ordinary commercial use, whereas these new " Kunial " alloys cost only a fraction of the price of beryllium.

The hardening principle of the new alloys was discovered by accident during experiments on Alumbro (an alloy of copper, zinc, and aluminium) designed to increase its resistance to corrosion. When about 5 per cent. of nickel was added for this purpose, it was found that the alloy became extremely hard. It was heated, quenched, and found to have become soft. Further experiments were made, and it was found that a series of alloys containing copper, nickel, and aluminium, if heated to about 800°C., quenched, and then reheated up to a maximum of 500°C., acquired great hardness and tensile strength. The Kunial series includes brass, copper, nickel-silver and bronze. An important feature of the new alloys is that a cold-worked alloy heated to 450°C. not only increases its hardness and tensile strength, but also its elongation; in other words, it does not become " over-worked " and brittle.

The possible applications of this discovery are wide, for it is claimed that it will greatly facilitate the commercial use of alloys, because the series can be used by manufacturers in the soft state and then hardened when the article has been made, whereas ordinary alloys, hardened by cold working, must be handled by the manufacturer after the hardening process is complete. Each alloy in the series is said to have a high degree of resistance to corrosion by sea-water.

Additional Plant at Nickel Works

THE International Nickel Co. of Canada, Ltd., is placing orders for the installation of four additional converters in the smelter at Copper Cliff, Ontario. The cost of the new installation will be approximately $1,000,000. The company has, during the past two months, been running its plants at 70 per cent. of its 1929 peak production.

Coloured Aluminium.

Exhibits at the British Industries Fair

FOR the first time in the history of the British Industries Fair samples of dyed metal have been exhibited this year. The metal is aluminium, and strips dyed in a variety of colours and effects are to be seen on the stand of the Dyestuffs Group of Imperial Chemical Industries, Ltd., at Olympia.

Under the new Gower process, which is now being operated in this country, aluminium may be permanently dyed in almost any shade or colour. The actual process is a simple one and is rendered possible by the oxidising properties which aluminium possesses as a metal. Aluminium oxide has definite mordant properties, so that on simple oxidation the surface of the metal becomes automatically prepared for the dyeing process. In the Gower process, oxidation is effected by an electrolytic method, in which the aluminium articles to be treated form the anode of an electrolytic cell. Electrolysis results in intensive oxidation of the surface of the aluminium, the porosity, flexibility and hardness of the anodic film so formed being governed by such factors as the current density and the temperature of the solution. Only dilute sulphuric acid, out of the various acid baths tried, has been proved capable of treating any form of aluminium whether wrought, cast, or in the form of alloys, and of permitting absolute control of the surface films formed. Dilute sulphuric acid, moreover, is the cheapest electrolyte conceivable.

The process of oxidation is carried out in three stages :— (1) Cleansing and polishing of the aluminium objects, (2) anode oxidation, and (3) washing the oxide film. Polishing is essential before immersion in the electrolyte, since any defect in the surface will be emphasised by the colour subsequently applied. The immersion time, which determines the depth and flexibility of the film varies from ten minutes to one hour, the e.m.f. being of the order of 10—15 volts, with the bath maintained at 15—20°C. After this treatment, the aluminium presents a silvery-white surface, and if it is now immersed for a few minutes in a bath containing an organic colouring matter, it will take up the colour similar to wool or cotton. This colour is subsequently made proof against abrasion by immersion in a " sealing-bath." Previous to this stage, the oxide film may be looked upon as having a crystalline structure, in which the component crystals are standing on end in a verticle position. The action of the " sealing-bath " is to cause these crystals to form a laminated structure, securely " locking in " the colour.

The colouring process enables deep penetration to be effected in a wide variety of colours, which may be either lustrous or matt. Most of the organic colouring matters, such as the anthraquinones and alizarins, may be used, and the finish is much more permanent than that given by lacquering or plating. The colour range extends from jet black and cream to the most delicate pastel shades, and includes the metallic colours—gold, bronze and copper. All such colours are sun-fast, but where exceptional heat fastness is required, mineral colouring matters, such as cobalt salts, have to be used.

Peculiar Properties of Iron-Aluminium Alloys

SOME peculiarities in the physical properties of iron-aluminium alloys were communicated to the Royal Society by Professor W. L. Bragg, F.R.S., at the meeting held on March 1. The joint authors of the original paper, Mr. C. Sykes and Mr. H. Evans, have investigated measurements of the resistivity of alloys of iron and aluminium containing from 11-16 per cent. aluminium by weight, and have shown that the resistivity of such alloys at room temperature depends on the rate of cooling of the specimens from a temperature of the order of 600°C. Alloys in this range consist of a single solid solution at all temperatures concerned. It is therefore concluded that rearrangement of atoms takes place in the alloys under slow cooling conditions, and the more regular arrangement so produced leads to a decrease in resistance. Experimental results were described, suggesting that the rearrangement of atoms in the space-lattice takes place over a considerable range of temperatures even under conditions of very slow cooling.

Some Recent Metallurgical Patents

Refining Magnesium

MAGNESIUM and magnesium alloys can be prepared for casting by melting with a flux composed of magnesium fluoride and magnesium chloride, the latter containing from 2-10 per cent of water. The temperature to which the metal is heated during melting and refining is kept below 800°C. A flux composed of 40 per cent. magnesium fluoride and 60 hydrated magnesium chloride is described. (See Specification No. 401,672, of F. Badger and British Mexium, Ltd.)

Enamelled Metals

ENAMELLED sheet iron, or vessels made therefrom, can be produced by applying the enamel to an alloy of iron with at least one of the metals whose oxides cause adhesion, the quantity of such metals being sufficient to cause adhesion. Cobalt and nickel are the most effective, but a few other metals such as manganese, copper, molybdenum, and tungsten may be employed, preferably only in conjunction with cobalt or nickel. An iron alloy containing 1 to 2 per cent. of nickel is suitable while, in the case of manganese, at least 2 per cent is essential. (See Specification No. 401,650, of J. Kreidl.)

Protective Metallic Coatings

ARTICLES of oxidizable metal or alloy, *e.g.* iron, steel, copper, nickel, or nickel alloys, can be protected either by first spraying on a coating of cadmium, antimony, bismuth, lead, magnesium, tin, or zinc and then a coating of aluminium, or alternatively by spraying on a coating of an alloy of aluminium with a small proportion of one of the metals specified, the coated article in either case being heated to a temperature of 650-1,200°C. The coated article, prior to heating, may be given a coating of bitumastic paint or other substance which will form a carbonaceous deposit when heated. The article is preferably cleaned before coating, for example by sand-blasting, and the coatings may be burnished or polished. (See Specification No. 400,752, of Metallisation, Ltd., and R. A. Parkes).

Treatment for Metallic Surfaces

A PROTECTIVE and electrically insulating coating can be formed on iron or steel articles by treatment with an aqueous solution containing a ferric salt or a soluble ferri salt of an organic carboxylic acid, e.g. ferric oxalate, tartrate, or salicylate, or a soluble ferri-oxalate. The solution is preferably acidulated, for example with sulphuric, phosphoric, or oxalic acid, the amount of acid added being insufficient to produce evolution of hydrogen, and the coating may be effected by anodic treatment in the solution. The solution containing the ferric salt may be made by dissolving a ferric salt such as ferric sulphate and a substance containing the desired acid radical, e.g. sodium oxalate, in the presence of acid. (See Specification No. 401,908, of Curtin-Howe Corporation, Ltd.)

Improving Alloys

IN a process for improving ferro-magnetic alloys which have been treated by repeated rolling or stretching, preferably with intermediate heating between the initial stretching steps, the alloys can be subjected after the final rolling or stretching step to a prolonged heating at 100-250°C. The process may be applied to iron-nickel alloys containing 30-80 per cent. of nickel or to an alloy containing 40 per cent. of nickel, 60 of iron and 3 of aluminium. In an example, rods of an iron-nickel alloy containing 50 per cent. of nickel are homogenised by heating at 800-900°C. for an hour, stretched to obtain a reduction of 10 per cent. in cross section, annealed for an hour at 900°C., stretched in the cold and then annealed, the stretching and intermediate annealing being repeated three times. After the final annealing the material is stretched in the cold to obtain a reduction in cross section of 60-70 per cent. and is heated for 24 hours at 130°C. and then allowed to cool slowly. (See Specification No. 400,395, of International General Electric Co.)

Nickel Alloys

MIXTURES of nickel with other metal, e.g., pulverulent alloys such as permalloy, can be obtained by the thermal decomposition of mixtures of nickel carbonyl with other metal carbonyl. Thus, nickel-coated iron may be treated with carbon monoxide at 225°C. and 200 atmospheres pressure. The nickel is entirely removed and the mixture of nickel and iron carbonyls obtained, after the addition of cobalt carbonyl and further iron carbonyl may be thermally decomposed in a hollow space to obtain a powder suitable for the preparation of an alloy or iron, nickel and cobalt. (See Specification No. 401,438, of J. Y. Johnson, communicated by I.G. Farbenindustrie.)

Carbon-Free Alloys

SUBSTANTIALLY carbon-free alloys can be produced from basic metals or alloys containing carbon by refining with difficultly reducible oxides of metals such as chromium, tungsten, molybdenum, tantalum, uranium, vanadium and zirconium in hydrogen or in an atmosphere containing a high percentage of hydrogen, for example fuel gases. The molten carbon-containing metal or alloy, preferably in an induction furnace, is treated with the refractory oxide or oxides under a hood filled with hydrogen at normal, increased, or reduced pressure. The hydrogen may contain a proportion of water vapour or other oxygen carrier, or of a volatilizable hydrocarbon. (See Specification No. 401,094, of Heraeus-Vacuum-Schmelze Akt.-Ges.

Non-Rusting Iron and Steel

IN the preparation of a non-rusting iron or steel alloy containing chromium, a molten chrome-iron alloy may be prepared by melting a mixture of 65 per cent. of chrome ore having 48 per cent. Cr_2O_3, 23 per cent. calcium silicide, 4 per cent. aluminium, 3 per cent. fluorspar, 2 per cent. a silicon iron containing 80 por cent. of silicon and 2 per cent. of lime and is then incorporated with molten iron, a fused mixture of 30 per cent. chrome ore, 25 per cent. lime, 20 per cent. beauxite, 15 per cent. fluorspar and 10 per cent iron oxide being added as a protective layer. In a modification the molten metal iron is added in portions to the molten alloy until the desired chrome alloy is produced, the slag mixture being present in the molten alloy. (See Specification No. 402,430, of V. Angelini.)

Colouring Metallic Surfaces

A COLOURED coating, which may also have corrosion-resisting properties, can be formed on aluminium or aluminium alloy by forming on the surface an adsorbent oxide coating and then precipitating in the coating a coloured metallic oxide by treating first with a solution of a metallic compound and then with an oxidising agent in solution, or vice versa. The adsorbent oxide coating may be produced by anodic treatment in sulphuric or chromic acid solutions, or chemically by treatment in a boiling solution of sodium carbonate and potassium dichromate. Details of concentration, temperature, and current density are given. The metallic compound used in the subsequent treatment may be a lead salt, *e.g.*, the acetate or nitrate, for the production of a brown oxide coating or a cobalt salt, *e.g.*, the acetate, nitrate sulphate, or chloride, for the production of a very dark brown or black oxide coating. The oxidising agent used is preferably a solution of potassium permanganate but may be, for example, a solution of a hypochlorite or chlorine water. (See Specification No. 401,270, of A. H. Stevens).

New Process for Stainless Steel

THE Anglo-American Steel Co., of London, is reported to be investigating the manufacture of stainless steel from the extensive iron sand deposits at Taranaki, New Zealand. Two electric furnaces would be used and 2,000,000 units of power would be required annually at a cost less than 0.25d. per unit.

Metallurgical Section

April 7, 1934

Cupola Melting Losses

THE January issue of the Quarterly Bulletin of the British Cast Iron Research Association contain a report on cupola melting losses. The author, Mr. J. G. Pearce, points out that the task of ascertaining foundry melting losses makes it of interest to know how much metal is irreparably lost. Most of the metal which goes into the cupola and does not find its way into the moulds cannot be regarded as irrecoverable, for it consists of small quantities which (a) adhere to the cupola brickwork; (b) collect in the joints between the bricks; (c) are mechanically entangled in the bed coke and slaggy material when the bottom is dropped; or (d) form a skull in the ladle.

Irrecoverable losses are of two kinds. In the first place, under certain conditions, a small amount of metal is lost by oxidation, particularly in a cupola which is highly oxidising, and even in an ordinary cupola when the charge is low in the stack and a normal air supply is being maintained. Although this loss is a small one, the conditions which produce it have a deleterious effect on the metal which is being melted. The second loss is caused by iron passing into the slag as ferrous oxide, also a matter of oxidation. Under good conditions a slag may contain ferrous oxide to the extent of 6.5 per cent., but in an oxidising cupola this figure may be doubled or trebled and may even reach 30 per cent. Out of every 100 parts of this slag, nearly 78 parts are shown by analysis to be metallic iron, and a slag containing 6.5 per cent. of ferrous oxide will therefore carry off slightly more than 5 per cent. of iron. Under oxidising conditions, moreover, the normal loss of silicon and manganese is also increased.

In the case of a large furnace cited by Mr. Pearce, a run of 86 tons of metal yielded 2 tons of slag, the slag thus being equivalent to 2.3 per cent. of the metal melted. This slag carried 10.3 per cent. of ferrous oxide, or 8 per cent. of metallic iron, and the actual loss of iron was therefore 0.18 per cent. or 4.2 lb. per ton of iron melted. Assuming good melting conditions yield a slag containing 5 per cent. of metallic iron, and that the slag is equivalent in weight to 2.5 per cent. of the metal melted, it will be evident that the amount of iron lost in the slag amounts to nearly 3 cwt. for each 100 tons of metal melted. It will therefore be seen that the actual amount of iron which is lost and cannot be recovered in ordinary cupola melting is small, but it is large enough to be taken in consideration where input must be balanced against output.

The actual need for keeping these losses under observation is not of so much consequence in respect of the actual amount of iron involved, but rather on account of the indications which they give of undesirable cupola melting conditions. The British Cast Iron Research Association has always stressed the importance of weighing the charges which entered the cupola and few foundries now omit to do so. In trying to strike a balance between metal purchases and output, the allowance required for sand on the pig must be made and the figure of 2 per cent. is a suitable one. Not only is the effective weight of pig iron diminished if the sand increases, but the proportion of limestone required to flux the sand is also increased.

Metallurgical Research

IN his presidential address at the annual meeting of the Institute of Metals early in March, Dr. H. Moore, director of the British Non-ferrous Metals Research Association, denied that the increasingly rapid progress of science and its application to every side of life were responsible for unpleasant signs of economic dislocation. He said he found it impossible to believe that our difficulties of the last few years would in any way have been lessened if science and its application had halted in their progress. There is, indeed, much to be said for the view that the effects of the industrial depression have been mitigated in some directions by scientific progress. Certainly some of the newer industries which have arisen purely as a result of the advance of science have suffered, far less than the primary producing industries and the long-established so-called "basic industries." In promoting the spread of scientific ideas throughout the metallurgical industries, the research associations were doing far more than merely making these industries more profitable to those who were dependent on them; they were also encouraging forces making for stability and ordered progress in civilised life.

Referring to the interdependence of ferrous and non-ferrous metallurgy, Dr. Moore said it would at once be admitted that on the purely scientific side the distinction between the two sides was wholly artificial. He mentioned the common ground of study in relation to corrosion, although stating that in the casting of metals the connection was less obvious. Dealing with the "intensive investigation of the creep of materials under stress at high temperatures," he particularly stressed that engineering and chemical progress continue to make still more insistent demands for materials to withstand high temperatures. Much of this work is necessarily empirical, amounting to the determination of the creep characteristics of steels of different types and the study of the effects of different alloy elements on creep. Attention is being given, however, to the

fundamental causes and mechanism of creep, which are probably much the same in the creep at atmospheric temperatures of metals and alloys of low melting points as in steels at high temperatures. The effects of crystal size and recrystallisation are more easily investigated at ordinary temperatures, and it seems probable that the study of creep in alloys of lead, tin and other metals of low melting point may also throw light on the mechanism of high temperature creep in alloys of high melting point, including steels.

The present tendency towards specialisation, Dr. Moore regarded as " a necessary evil," but made an appeal for the postponement of " cramping specialisation " by extending the years of real education in which wider interests might grow. He suggested that the development in earlier years of a wider scientific knowledge " will make it easier for members of an institute to understand each other and to meet on common ground, when, in later years, they have become concentrated on diverse special interests."

The Late Dr. Walter Rosenhain

By the death of Dr. Walter Rosenhain, F.R.S., the world has lost the service of a brilliant metallurgist. Even four days before his death, on March 17, Dr. Rosenhain was the recipient of yet one more honour which he should have lived to enjoy, for he was to have been present at Birmingham University on the occasion of the presentation of the Thomas Turner medals. These medals are awarded to commemorate the contribution made to the science of metallurgy by Thomas Turner, the first professor in that subject at Birmingham University, and this year the gold medal was awarded to Dr. Rosenhain. It was in 1908 that Dr. Rosenhain came to the National Physical Laboratory and was appointed first superintendent of the Department of Metallurgy and Metallurgical Chemistry, which was created only two years earlier. In the twenty-three years that he held that post this department has grown so immensely in size and renown that it is now regarded as one of the most important metallurgical research laboratories in the world.

Dr. Rosenhain, who was 58, came to England from Australia as a holder of one of the research scholarships awarded by the Royal Commission for the Great Exhibition of 1851, and in the early part of his career he worked under Professor (now Sir Alfred) Ewing, the late Sir William Roberts-Austin, and the late Professor J. C. Arnold. He was elected a Fellow of the Royal Society in 1913, and was President of the Institute of Metals from 1928 to 1930.

Developing the Use of Molybdenum

Developments which have taken place in the use of molybdenum were recently discussed by members of the research and development staff of the Climax Molybdenum Co., at a meeting of one of the local sections of the American Society for Metals. Mr. A. J. Herzig pointed out that molybdenum was a metal akin to tungsten, with a very high melting point, and comparatively small additions of it very effective. It dissolves in ferrite and thereby strengthens it; it also enters into the composition of the carbides, toughening them. In this way it accentuates the several beneficial effects of other metals, such as nickel or chromium. Without heat treatment, molybdenum also raises the tensile strength and hardness. It raises the thermal critical point in heating and lowers it in cooling, making thermal changes sluggish. In other directions it guards temper brittleness, embrittlement being almost completely eliminated by 0.7 per cent.; it improves machinability at a given hardness, and does not interfere with welding. Molybdenum also shows a remarkable specific effect in raising the strength of iron alloys at high working temperatures. Its helpfulness in preventing intergranular corrosion in stainless steel and in accentuating the effect of copper in certain rust-resisting steels, are also noteworthy.

The amount of molybdenum used in the United States in the making of cast iron, said Mr. C. Loeb, has doubled every year since 1929, and there must be very good reasons for this, taking the general condition of the cast iron industry into consideration. Apart from the question of cost and the fact that the metal was not subject to loss in application, it was known that molybdenum is the only single metal that raises the deflection obtainable in a cast iron test bar, at the same time as it raises the hardness. In hardness, an extreme is reached in chilled austenitic molybdenum cast iron; this has tough carbides stiffening an austenitic matrix which further work-hardens with wear. Like nickel, molybdenum also gives high machinable hardness in cast iron by strengthening the matrix. Another foundry benefit derived from the use of molybdenum is its tendency to eliminate porosity, thereby making it possible to use a non-shrinking base, and still obtain a close-grained casting.

American Metals and Alloys

Platinum provided a fascinating display at the Fourteenth Chemical Exposition which was held in New York in December. Included among the exhibits were platinum gauze catalysts which have revolutionised the manufacture of nitric acid by the oxidation of ammonia, and also spinnerettes for rayon factories. Screens and wire cloth were to be specially noted for fineness and corrosion-resistance, the latter being claimed to extend the life of the screen as much as sixteen times. A new ductile alloy of nickel, molybdenum and iron, a tough nickel-molybdenum-chromium-iron alloy, and a strong nickel-silicon-copper-aluminium alloy were recommended as corrosion resistance metals for special service, for the present tendency seems to be to build a specific alloy exactly suited to each problem of severe service. Nickel-clad steel was recommended for tanks, mixers and conveyors, in a great variety of process industries, and also for tank cars. In the case of assemblies of large diameter pipes, this nickel-clad steel was said to cost half as much as pipe of the solid corrosion-resisting material. Mild carbon steel clad with fine quality stainless steel was claimed to offer sturdy construction and a corrosion-resistant surface at half the cost of a solid stainless steel construction. For the handling of caustic soda, nickel and its alloys were recommended, particularly for evaporator body construction, and for pumps and valves. High-silicon ferrous alloys received a due share of prominence, and special attention was called to an alloy capable of handling hydrochloric acid at all concentrations and all temperatures up to the boiling point.

The World's Nickel Industry

Position Reviewed by the International Nickel Company of Canada

AFTER three successive reports dealing with trade recession and diminishing profits the International Nickel Company of Canada reports for 1933 a substantial upturn in business. Since May, 1932, there has been a gradual increase in the volume of nickel sales and, beginning with the second quarter of 1933, profits have been realised each month. The most encouraging feature of the year's improvement is that it has been well spread among all consuming fields and that nearly every buyer took more nickel than in 1932. Copper and platinum metals sales during the year under review were substantially greater and better prices were obtained than in the preceding year.

Sales of Nickel and Copper

Sales of nickel in all forms, including nickel in alloys, amounted to 74,356,969 lb. compared with 34,406,953 lb. in 1932, an increase of 116 per cent. The world's consumption of nickel in all forms aggregated 96,000,000 lb. compared with 57,000,000 lb. in 1932 and 73,000,000 lb. in 1931. Sales of nickel in refinery products of Port Colborne (Canada) and Clydach (Wales) amounted to 61,353,495 lb. compared with 57,000,000 lb. in 1932 and 73,000,000 lb. in 1931. Sales of Monel metal, a product made direct from Creighton ore, totalled 9,101,219 lb. compared with 7,624,298 lb. in 1932, an increase of 19 per cent.; and sales of rolled nickel, 6,287,991 lb. were up 60 per cent. Copper sales, inclusive of copper in sulphate produced in Wales, increased from 57,662,789 lb. to 113,682,312 lb., or 97 per cent. Gold sales were 21,355 ounces compared with 23,042 ounces in 1932; silver sales were 876,303 ounces compared with 652,638 ounces in 1932 and sales of the platinum metals were 77,198 ounces compared with 19,300 ounces in 1932.

Operations at the concentrator at Ontario, Canada, were increased during the year, the total ore milled amounting to 996,515 tons. Improvement in metallurgy continues and is reflected in better recoveries and lower costs. The Copper Cliff smelter produced 53,186 tons of bessemer matte and 61,385 tons of blister copper. Two reverberatory furnaces were operated on mill concentrates until the end of June and three for the balance of the year. One blast furnace was used continuously for the Orford process. This was the first full year of operation for the new Orford process plant and the results were so satisfactory from the standpoint of costs and quality that the wisdom of moving from Port Colborne to Copper Cliff has been proved. The Coniston smelter resumed operations in June with two blast furnaces and two converters and treated 328,640 tons of ore and produced 20,645 tons of bessemer matte. The smelter stack was rebuilt during the year and the plant generally shows a high degree of maintenance.

The Clydach and Acton Refineries

The Port Colborne Refinery, Ontario, produced 41,496,664 lb. of nickel in the form of electrolytic cathodes and nickel in oxide. The output of nickel at the Clydach Refinery, Wales (Mond Nickel Co., Ltd.), in 1933 was 20,760,117 lb. compared with 7,416,464 lb. for 1932, an increase of 180 per cent. Except for a short period when the works were closed due to flood damage the refinery ran continuously. Due to increased production and minor improvements and economies, operating costs were improved and are now lower than at any previous time. Research work was carried on throughout the year, primarily in connection with experimental refining by the high pressure carbonyl process. The average number of men employed at this refinery during the year was 722 as compared with 458 during 1932.

Although production of the platinum metals decreased to 53,555 ounces, compared with 62,893 ounces in 1932, the increased scale of operations at the Port Colborne and Clydach refineries resulted in an increase in the quantity of platinum metals to be processed at the Acton Refinery, London (Mond Metal Co., Ltd.). Progress was made in the metallurgy of the platinum metals with the result that the yield and the purity have been improved. Costs were again lowered at this refinery, and research and development work have been carried on actively in co-operation with numerous firms also interested in extending the uses of the platinum metals.

The increase in world nickel consumption from 57,000,000 lb. in 1932 to 96,000,000 lb. in 1933 is impressive and indicates a healthy growth in the uses of nickel and such a market as has seldom been exceeded in the past. It is, moreover, significant to note that the distribution of consumption, both as to countries and uses, reflects natural and orderly progress toward improved industrial applications.

The channels through which nickel has passed to the ultimate consumer have continued to be mainly those industrial applications, either old-established or of more recent development, which have been the principal support of the industry since 1921. Many of the more recently developed uses for nickel have, however, made even greater strides during 1933 than the industry as a whole. If there has been any one factor more important than others in the recovery of the nickel market, it has been the increase during 1933 in the production and sales of automotive vehicles, which has occurred in practically all industrial countries. The continued liquidation during the preceding year, to almost negligible tonnage, of nickel-bearing scrap as well as of nickel-bearing products, also contributed to the increased demand. Nickel-consuming industries appear now to be operating almost wholly on the basis of newly-mined nickel.

New Uses for Nickel Steels

The automotive industry was the outstanding consumer of nickel steel in 1933 and it is interesting to note that the consumption of nickel per car was well maintained notwithstanding the prevailing trend toward the production of low-priced cars. Nickel steel has been used in locomotive equipment, particularly in Europe, in oil-drilling and oil-refining equipment and in the machinery field generally. Several thousand tons of 3.5 per cent. nickel steel are specified for the new San Francisco-Oakland bridge. The application of nickel and nickel-chromium steels in the design of mine cages has been studied in France and Belgium, and standardised designs have been developed which permit considerable saving in weight and increase in "pay" load. This development promises to be of substantial interest and value in connection with deep shaft mining. Under the stimulus of orders from an important railroad, nickel steel boiler plate is now manufactured in Great Britain, and this has led to the adoption of nickel steel by another leading British railroad.

Nickel steels are for the greater part sold direct by the steelmakers to the larger manufacturers of automobiles, machinery and to other large metal-consuming industries and their requirements, often special in character, are readily met. The small manufacturer and user of steels is also a factor in nickel consumption and quite definitely one of growing importance. His requirements must, because of their volume, be met largely with standard products. In this respect the nickel alloy steels enjoy an advantage in that because of long usage and established practice they have become well standardised and generally available. Your company has co-operated with steel jobbers and warehouses in arranging for the stocking of a broad list of sizes and compositions of the standard nickel steels, as well as in the dissemination of technical information concerning them.

The year has witnessed several significant developments in the use of this nickel-chromium alloy. The most spectacular undoubtedly was the design in stainless steel of a three-car articulated train for the Chicago, Burlington and Quincy Railroad, which is now under construction at the Philadelphia plant of the Budd Manufacturing Co. This constructive adventure in railroad engineering probably forecasts a significant broadening of the industrial opportunity for this alloy, and the extension of its use into structural fields. A similar development has been that of the use of stainless steel for aircraft frame and wing construction where advantage is

taken of the high mechanical properties in securing light and dependable construction.

Outstanding among the year's developments in nickel cast iron was the growing popularity of nickel-chromium cast iron for steel mill rolls. These are now of several types including the nickel-chromium-molybdenum " grain " roll for the hot-rolling of steel and the " Ni-Hard " chilled roll for cold-rolling. These alloy irons have become standard compositions for practically all roll makers. The " Ni-Hard " iron is used to-day for a wide variety of parts used in mining and in grinding and pulverising equipment. The commercial value and popularity of nickel cast iron, throughout the world, ten years after its introduction can perhaps best be realised from the fact that to-day many iron foundries are producing and selling one or more of the special alloy irons—"Ni-Hard," " Ni-Resist," " Ni-Tensyliron,"—which contain fairly substantial amounts of nickel, and several hundred foundries are producing the nickel alloy irons of lower alloy content.

Nickel Copper Alloys

The use of 30 per cent. nickel-copper alloy for marine condenser tubes registered a substantial gain in 1933, particularly in the United States. Tubes of cupro-nickel are now manufactured and sold by the principal tube manufacturers throughout the world.

Monel metal found increasing demand throughout the year in its normal markets—chemical, engineering and household. Of outstanding importance has been the acceptance accorded Monel metal hot water tanks, range boilers and storage tanks for automatic gas and electric hot water heaters in the home. Of considerable engineering interest was the adoption of Monel metal for the heavy forgings of gate and valve equipment on the Madden and the Boulder Dams. Through certain improvements in Huntingdon mill practice it was possible for this equipment to supply large shafts with greatly increased mechanical properties, including, for example, a minimum yield point of 70,000 lb. per square inch.

Iconel, the new nickel-chromium alloy which was announced in 1932, is finding new applications in several interesting directions, notably in the sheathing construction of electrical heating units. It has also been made available during the year in the form of non-staining window screen.

There was marked improvement in the copper market during 1933. The volume of world consumption rose from 1,077,000 short tons in 1932 to about 1,273,000 tons in 1933, and the world price, c.i.f. European ports, rose from its low of 4.9 cents per lb. early in the year to 8.2 cents per lb. at the close of the year. Since the imposition of a United States tariff on copper in June, 1932, the International Metal Co., of Canada, has been selling its copper chiefly in Canada, the United Kingdom and Europe, and it may be noted that the consumption in these countries has recovered practically to its normal level. Production and consumption of copper outside the United States are of about normal proportions.

Platinum and Palladium

The world consumption of " new " platinum during 1933 is estimated to have been about 175,000 ounces, as compared with an estimated consumption of 75,000 ounces in 1932 and a normal consumption of perhaps 200,000 to 225,000 ounces. The New York price of platinum rose from $24 per ounce early in 1933 to about $38 per ounce at the close of the year. Increased activity in the platinum market has followed the substitution of platinum for white and the coloured golds in the jewellery field, due partly to the restrictions which have in some countries attended the industrial use of gold. The greater demand for platinum in certain industrial and chemical fields was due primarily to the more favourable competitive price position of platinum as compared with gold and other metals. Probably for the first time the amount of platinum used in the industrial arts substantially exceeded that used for jewellery. Important in this respect has been the well maintained demand for platinum and platinum alloys for spinnerets in the rayon industry and for gauze catalysts in the ammonia-oxidation synthesis of artificial nitrates.

Palladium has likewise fared well during the year, its price rising from about $17 per ounce in New York at the outset of the year, to about $23 toward the close. The consumption of palladium as well as of platinum for dental golds and white dental alloys has continued to increase and both metals have secured a fairly broad and stable market in this field. Of interest has been the introduction and use of palladium leaf or foil for certain style features and decorative effects in connection with ladies' shoes, hats and gloves, as well as on picture framing and outdoor and indoor signs and decorations, where gold was formerly employed.

Institute of Metals

Student Members Visit Belgian Engineering Works

THE first educational tour to be arranged by the Institute of Metals for its student members begins next week. On Sunday morning, April 8, the party, numbering over 40, will leave London, en route for Belgium. They will spend April 9 and 10 in the Liége district, visiting the works of Ste. Ame. John Cockerill, Ste. Ame. d'Ougrée Marihaye, Ste. Ame des Mines et Fonderies de Zinc de la Vieille-Montagne, and Fabrique Nationale d'Armes de Guerre. They will then travel to Charleroi and on April 11 visits will be paid to Ateliers de Constructions Electriques de Charleroi and Ste. Ame. des Laminoirs, Hauts Fourneaux, Forges, Fonderies et Usines de la Providence. On April 12 the party is due to leave Charleroi for Brussels where the day will be spent in seeing the Belgian capital and visiting the University. Leaving Brussels on the following morning a visit will be paid to Bruges, from where the party will leave for London on April 14.

As the cost per head to the students participating is only £6 10s., it is not surprising that so many young metallurgists have taken advantage of this tour, which has been arranged by the Institute of Metals, with the co-operation of the National Union of Students. The large participation in the tour has been most encouraging to the Council of the Institute of Metals, and it is expected that visits to other industrial centres on the Continent will be arranged at a later date. Students desirous of participating in future tours should communicate with the secretary, Mr. G. Shaw Scott, the Institute of Metals, 36 Victoria Street, London, S.W.1.

The Bessemer Gold Medal

Acceptance by H.M. King George

THE King has consented to accept the 1934 Bessemer Gold Medal, which will be handed to him at Buckingham Palace on May 30. Sir Robert Hadfield, chairman of Hadfields, Ltd., Sheffield, who announced the King's acceptance at the recent annual general meeting of the company, said the deputation selected by the Council of the Iron and Steel Institute to make the presentation would consist of the President of the Institute, Mr. W. R. Lysaght, himself, the senior past-president, Sir Harold Carpenter, the honorary treasurer, and Mr. K. Headlam Morley, the secretary.

The Bessemer Medal was founded in 1873 by the late Sir Henry Bessemer and has been awarded annually since that date. It was accepted by Queen Victoria in 1899. Sir Robert Hadfield had the honour, during his term of office as the President of the Institute in 1906, of personally handing the medal to King Edward. The last three reigning monarchs have therefore added to the dignity of the Iron and Steel Institute in ther acceptance of this " blue riband of the metallurgical world."

Carbide Manufacture in Poland

THE Polish cartel court has announced termination of the carbide agreements between the Polish Calcium Carbide Cartel and the State nitrogen works in Chorzow, thus permitting a resumption of carbide production by the Chorzow factory. The Ministry of Industry and Commerce hopes to reduce prices by approximately 30 per cent. and thus to stimulate sales. Poland exported 6,800 tons of carbide in 1930, but only 3,000 tons in 1932.

Sodium Carbonate in Foundry Practice

A Cleansing Flux and Desulphurising Agent

DEVELOPMENTS in the use of sodium carbonate in foundry practice, were described by Mr. N. L. Evans, B.Sc., A.I.C., of the Research Department of I.C.I. (Alkali), Ltd., Winnington, in a paper read before the Sheffield branch of the Institute of British Foundrymen, on March 16.

Sodium carbonate, said Mr. Evans, has recently attracted a considerable amount of attention in this country and abroad owing to its efficiency as a cleansing flux and desulphurising agent for cast iron and certain non-ferrous metals. It has a useful operating range of about 600° C., from its melting point at 851° C. up to 1,450° C.; the range of metals which may be treated therefore includes copper, brass, bronze and cast iron. The material is supplied primarily for addition to the cupola with the charge, and although, on account of the presence of siliceous slag, no very great reduction in sulphur normally takes place, the metal is kept free from non-metallic inclusions. Moreover, the cupola walls are kept very clean, so that the daily patching is much more easily carried out and ganisters saved.

An improved form of sodium carbonate has now been marketed for foundry use under the name of "granular ash"; this material is almost completely free from dust and so makes for much greater economy in use. Sodium carbonate is also supplied for use in a cupola in the form of fused blocks weighing 4 lb. each.

A New Design in Forehearths

One of the primary needs when any metal is used with a flux is to ensure efficient separation of the flux so that it is not poured into the mould. With this in view, attention has recently been devoted to the development of the teapot type of ladle which embodies a syphon principle, the metal being drawn from the bottom of a ladle. Another device particularly adapted to mass production foundries is the forehearth, an ideal place for carrying out the treatment of the metal with the sodium carbonate. The ordinary type of forehearth which is also used to preheat the blast is not satisfactory, but a new design has recently been put on the market which has a permanent opening in the top through which carbonate can be introduced. A slag trap is fitted between the cupola and receiver since it is most important to prevent siliceous slag entering the receiver. Siliceous slag has the effect of reversing the desulphurising action of sodium carbonate with the result that sulphides of iron and manganese are reformed and returned to the melt.

The lecturer quoted figures showing the reduction in sulphur normally obtained, and these emphasised the importance of carrying out the process in the absence of siliceous material. For this reason, metal poured from a 500 ton tilting mixer which is drawn from below the slag level, gives an absolutely consistent sulphur reduction of 50 per cent., whereas if slag is allowed to become mixed with the soda flux much less than 50 per cent. of the sulphur can be removed from the metal.

Grey Iron Castings

In referring to the process in connection with grey iron castings, Mr. Evans stressed the point that soundness and machinability are much more important, generally speaking, than tensile strength. The determination of the latter depends on the use of a test bar, which seldom gives a true representation of the properties of the casting itself. Owing to its degasifying action, sodium carbonate helps to eliminate such defects as shrinkage cavities, gas holes and the like, and by reducing the sulphur content and prevening segregation of this element it ensures a casting which can be readily machined. The sodium carbonate process is specially recommended for cast iron chemical plant ingot moulds and chilled rolls.

So far as Tropenas steel castings are concerned, the process is in almost universal use in this country. Not only does the removal of sulphur make the choice of raw materials much wider, but the removal of non-metallic inclusions from the metal results in a very high ductility in relation to the tensile strength. The process is also used for treating iron from the blast furnace or mixer for making Bessemer and open-hearth steel.

The lecturer also referred to the possibility of using sodium carbonate in the basic open hearth furnace. Work by Lowry, in America, has shown the advantage of using a mixture of sodium carbonate and fluorspar instead of fluorspar alone, and it is suggested that this may have a profound effect upon the value of the resulting slag as a fertiliser. Brief reference was made to the work which is still in the experimental stage on the catalytic effects of sodium carbonate, firstly in accelerating the rate of production of iron ores, and secondly in increasing the efficiency of gas producers, directed towards the production of a gas containing less undecomposed steam and carbon dioxide and more carbon monoxide and hydrogen.

Finally, Mr. Evans referred to the value of sodium carbonate in connection with non-ferrous metal founding. In melting brass and bronze, swarf deoxidation is necessary and it is essential that the entrained oxides should be removed from the melt before casting. Sodium carbonate has been shown to be one of the most suitable agents for this purpose since it forms a very fluid slag, and is not unduly volatile at the temperature of molten brass. The principle involved in this is, of course, exactly the same as that whereby oxides, silicates and sulphides are removed from cast iron.

British Aluminium Co., Ltd.

A Desire for Increased Import Duties

WORLD consumption of aluminium during 1933 was on a slightly higher level, but the company's sales fell somewhat and their production was severely restricted, said Mr. R. W. Cooper (the chairman) at an ordinary general meeting of the British Aluminium Co., Ltd., held in London on March 27.

The home market sales, continued Mr. Cooper, were especially disappointing, all the more so because of an increase in the home consumption. The decided increase in foreign imports and competition during the closing months of 1932 was progressively evident during 1933, particularly in rolling mill products. Ways and means had been found by importers more than to counteract the entirely inadequate protection of the existing 10 per cent. duty on ingot metal and rolling mill products, and the importing countries had set up prohibitive barriers, making retaliation in their territories impossible. In their own countries prices were approximately 25 per cent. higher than here, and yet importers sold aluminium products here at less than 70 per cent. of their home prices, after having paid freight, duty and other incidental charges. This state of affairs was largely brought about by the aid of subsidies granted by foreign Governments to their exporters. The only effective answer was a drastically increased scale of import duties.

The company had stated its case to the appropriate authorities, and had pointed out the unsettling effect to home consumers of the instability caused by this unhealthy cutting of prices. The British Government was directly concerned with the position of the company by reason of its guarantee as to principal and interest of the £2,500,000 loan of the company's subsidiary, the North British Aluminium Co. Indirectly, also, the Government was concerned in consideration of home supplies of an essential metal, together with the employment of British labour and revenue derived from taxation of profits. The company, on its part, had entered into onerous obligations to the Government so as to ensure a national supply of aluminium, but under existing conditions it was increasingly difficult for the company to fulfil those obligations. A greater measure of support and encouragement on the part of the Government was therefore what the national industries awaited and required. In view of the export difficulties, it became all the more necessary that the home market should be secured to the home producers.

Some Recent Metallurgical Patents

Treating Metal Waste

SMALL waste metal, such as turnings, chips, etc., is heated to about 300°-800° C. in a reducing atmosphere to expel volatile matter and to soften and anneal the metal without melting, sifted, passed to a magnetic separator, and briquetted. Oil vapours expelled may be condensed either in original or cracked form and may be used for heating the furnace. The reducing atmosphere may be carbon monoxide to which may be added chlorine or the vapour of a volatile halide such as boron trichloride. (See Specification 403,179, of D. R. Tullis and P. Oakley.)

Magnesium Alloys

IN a method of melting, or purifying magnesium, and magnesium alloys, the molten metal or alloy is agitated with a fluid flux of calcium chloride and sodium chloride in the presence of a protective atmosphere that inhibits oxidation. The flux may also contain barium chloride, or a fluoride of an alkali or an alkaline earth metal. To provide the protective atmosphere sulphur in vapour or solid form, nitrogen containing carbon bisulphide, or a volatilisable fluorine compound may be introduced into the melting pot, or fluorine or a fluorine compound that is gaseous at ordinary temperature, with or without a diluent gas, may be passed over the surface of the metal. (See Specification 403,891, of Dow Chemical Co.)

Metallurgical Fuel

THE combustion of fuels for metallurgical furnaces can be improved by the addition to the fuel charge of a mixture containing one or several oxides or salts of the rare earths, such as cerium or thorium or of barium together with an alkali chloride. Compounds of metals with different degrees of oxidation, e.g., oxides or other compounds of manganese, iron, chromium, lead, copper, or mixtures thereof, and oxidising salts, e.g., nitrates, permanganates, or chlorates of the alkali or alkaline earth metals, may also be included in the mixture. In an example a mixture of cerium oxide 10-20 per cent., barium nitrate 30-40 per cent. and sodium chloride 40-60 per cent. is employed, one to two kilograms being added to each ton of fuel. The mixture may be distributed in the fuel in the form of powder or of an aqueous solution or suspension. (See Specification 403,770, of E. Lubovitch.)

Coating with Metal

A RELATIVELY hard layer of aluminium magnesium alloy can be formed on the surface of aluminium or aluminium alloy articles by packing the articles in comminuted magnesium, with or without a small percentage of magnesium oxide, and heating at a temperature above 250° C., preferably between 250° C. and 460° C. An inert gas, e.g., carbon dioxide, may be introduced into the heating furnace, or an air-tight receptacle may be used. The article is preferably cleaned and given a slightly rough surface prior to the treatment, e.g., by rubbing with an abrasive or by treatment with acids or alkalies. The comminuted magnesium may be magnesium powder or fine chips produced by machining a magnesium ingot. The process is stated to be applicable for the production of a hard, wear-resisting surface on aluminium pistons for internal combustion engines. (See Specification 402,609, of A. H. Stevens.)

Hardening Alloys

IN the manufacture of alloys for cutting tools, one or more hard metal nitrides or carbides can be incorporated in a starting material capable of being precipitation-hardened and the resultant alloy is subjected to a precipitation-hardening treatment. In an example fine-grained iron-titanium powder is mixed with titanium nitride and the mass sintered with or without pressure and by direct or indirect heating. The alloy thus produced is precipitation-hardened by cooling from a suitable high temperature and then heated to a temperature at which the hardening occurs. The titanium may be replaced by other metals such as copper. (See Specification 402,742, of F. Krupp Akt.-Ges.)

Cobalt Alloys

COBALT powder obtained by electro-deposition is treated in order to reduce any oxide present by heating at 600° C. first in hydrogen and then in a vacuum and finally cooling in a vacuum. A mixture of the cobalt powder with carbide of tungsten or tantalum may be heated to a semi-fusion in order to effect agglomeration of the carbide for the production of cutting tools. Tantalum carbide, when used should be first heated in a vacuum at 800° C. to remove occluded hydrogen. The cobalt powder may be heated under pressure with tungsten and carbon to produce a carburised and sintered mass. (See Specification 403,281, of British Thomson-Houston, Ltd.)

Molybdenum Coatings

CONTINUOUS coating of molybdenum are applied to articles of other materials, e.g., iron or nickel, by applying to the article a thin coating of a molybdenum compound in a colloidal state and heating in a reducing atmosphere at over 900° C. Colloidal molybdic acid formed by heating crystalline ammonium molybdate *in vacuo*, is a suitable compound. The coated articles are suitable for medical apparatus, and internal parts, such as support wires, of gasfilled electric incandescent or glow discharge lamps. In the lamps the molybdenum prevents the release of gaseous impurities from the cores, and absorbs gaseous impurities in the filling. (See Specification 402,916, of the General Electric Co., Ltd.)

Aluminium Alloys

ALUMINIUM alloys containing 0.5-5 per cent. of copper, 0.5-3 per cent. of nickel, 0.1-2.5 per cent of magnesium, 0.2-2 per cent. of iron, and 0.2-2.5 per cent. of silicon, are improved by the addition of up to 1 per cent. of cerium. One or more of the metals manganese, chromium, and titanium may be present. The alloys may be aged at not over 300° C., and such ageing may be preceded by quenching from 480°-570° C. The alloys may be made by adding to molten aluminium a number of aluminium alloys each containing one or more of the constituent elements, the magnesium being added last as such; or the cerium may be added as metal or as an alloy with any of the other metals. (See Specification 403,700, of J. Stone and Co., Ltd., A. J. Murphy and S. A. E. Williams.)

Precipitating Metals

COPPER and other metals more electropositive than copper, particularly nickel and iron, are precipitated from solutions by means of powdered aluminium in the presence of activating agents which wholly or partly remove the oxide layer from the surface of the aluminium, such as hydrochloric acid or a chloride. The aluminium may be alloyed with more electro-positive metals such as calcium. Precipitates of varying fineness or coarseness may be obtained by using aluminium of corresponding size. In some cases, the solution may be hot; for example lead may be precipitated at 40°-50° C. Different metals may be precipitated successively from mixed solutions by successive applications of different activating agents, or of different amounts of the same agent, or of different temperatures. (See Specification 403,469, of Trefileries et Laminoirs du Havre.)

Alkaline Earth Alloys

ALLOYS of the alkaline earth metals, including magnesium and beryllium, with metals that do not readily alloy with aluminium, such as lead, can be made by mixing together the metal such as lead and an aluminium alloy containing the alkaline earth metal and the metal to be alloyed therewith. Pieces or lumps of grains of an alkaline earth metal compound may be added to a bath of aluminium, and after the reduction of the compound, molten lead is added to the bath; alternatively the compound may be added to a bath comprising aluminium and lead. Alloys of berrylium may be prepared from beryl by first making an aluminium-beryllium-silicon alloy from the mineral and adding the complementary metal, e.g., cadmium. (See Specification 403,120, of G. N. Kirsebom and Calloy, Ltd.)

Metallurgical Section

May 5, 1934

Solubility of Gases in Aluminium

A RECENT issue of " Metallwirtschaft " (February 2 and 9) contains the result of some investigations on the solubility of gases in copper and aluminium. The authors, Röntgen and Möller, conducted their investigations at the University Institute of Metallurgy and Electro-Metallurgy, Aachen. Employing aluminium of very high purity and pure copper, they found a marked difference between the behaviour of the two metals. The gases dealt with included nitrogen, hydrogen, carbon dioxide and carbon monoxide, and apart from pure copper and pure aluminium, some intermediate high copper-aluminium and high aluminium-copper alloys were also investigated. The work was carried out in two different furnaces, with temperatures reaching 1,080° and 1,450° respectively, special precautions being adopted in respect of crucibles, etc. Working temperature constancy was also ensured, and to increase still further the degree of accuracy, the largest practicable amounts of metal were employed. Measurements were made by first heating the furnace to 1,050° to 1,150°, simultaneously evacuating it. By this means the small residual amounts of gas were continuously expelled, and only when the vacuum at these temperatures were sufficiently high (about 10^{-4} mm.) was the measured gas admitted. Data was then determined during slow cooling, and for each measurement the furnace was kept at a constant temperature for 25 to 45 minutes. By doing that it was possible to obtain values which did not deviate by more than 0.03 cc. from the straight lines between 1,070° and 470°.

At the melting point of pure aluminium an uptake at 0.22 cc. per 100 grams was found, but no solubility could be measured in the solid state. In the case of aluminium alloyed with 3 per cent. copper the uptake at the melting point of 657° was about 017 cc. Pure aluminium at 690° reached 0.27 cc. per 100 grams, at 866° it was 1.45 cc.; at 1,096°, 5.00 cc.; at 1,233°, 8.02 cc. Gasification with wet hydrogen (saturated at 15°) showed no marked difference in behaviour as compared with dry hydrogen.

A New Corrosion Testing Station

A NEW testing station has been opened at Mersea Island, on the coast of Essex, for the purpose of investigating the immunity of metals and paints from deterioration due to the action of sea air, ozone and sunlight. The mud flats adjacent to this station are covered by the sea at each tide and therefore provide an ideal site for examining corrosive action due to sea air and attendant marine agencies. Specimens under test will be so placed that they are actually immersed in the sea for a period of one to two hours at high water. When the water recedes they will then become exposed to the action of sun and wind, and still later to the action of ozone as the latter is released by the action of the sun on the mud. Other tests, such as total immersion in sea water for any required period, will also be arranged.

This testing station was originally started by Mr. F. E. Robinson, of the Marconi Company, but its scope will now be extended under the supervision of Mr. L. M. Robinson. Its services will be at the disposal of public authorities and engineers who wish to obtain an independent report upon materials, and also for manufacturers who wish to have their products tested under natural conditions. Such testing is much more conclusive and exhaustive than the usual method of spraying specimens with sea water in a closed chamber. Under the latter conditions the specimen is more or less at the same temperature throughout the duration of the test, and therefore lacks the important factors which may give rise to serious trouble. Secondly, the sprayed salt solution usually remains constant in strength, whereas, under actual conditions of outdoor exposure, the sun evaporates the splashed sea water and leaves a crust of dry salt which subsequently may be washed into cracks or pores in the form of a more concentrated solution. Further, the possible disintegrating effects of sun and ozone in combination are not reproduced in artificial methods of testing, and it should be remembered that ozone is one of the most destructive agencies connected with corrosion by sea water and sea air.

The British Iron and Steel Federation

THE National Federation of Iron and Steel Manufacturers will in future be known as the British Iron and Steel Federation. The revised constitution was adopted at a special general meeting held in London on April 19, four out of every five of the voters being in favour. A resolution was also passed giving special direction to the council and executive committee to be appointed under the revised constitution, to the effect that they shall give their earnest attention forthwith to the measures to be taken in collaboration with associations in the industry. They are to promote the maximum manufacturing and commercial efficiency throughout the industry; secondly, they are to expand the export trade in iron and steel products; thirdly, they are to obtain the affiliation of associations.

The president, Mr. James Henderson, moved a special vote of thanks to the National Committee, the various sub-committees and the revision committee for their unremitting labours over many months, which had

resulted in this conclusion. He considered this to be the most important step that the industry collectively had even taken. He also pointed out that the recent increase in production was mainly due to the home market. Imports were still at the rate of one and a half million tons a year, with a rising tendency, and effective measures must be taken, in collaboration with the Government, to divert to our own people the employment those imports represented. In March, the industry was working at 80 per cent. of its estimated capacity, and this was a much higher rate than existed in any other steel-producing country.

Nickel Steel and Marine Corrosion

THE 14th (interim) report of the Institution of Civil Engineers on the deterioration of structures in sea water, recently published by the Department of Scientific and Industrial Research contains the final results of the second series of ferrous specimens after ten years' exposure at Plymouth and at Colombo. The samples which were exposed to conditions of aerial, alternating immersion and complete immersion attack, comprised pure iron, mild steel, medium carbon steel, copper steel, nickel steel and cast iron. The excellent behaviour of the high-nickel steels confirm the results given in earlier reports. In the Plymouth series, 36 per cent. nickel steel was practically perfect against aerial corrosion. For alternating corrosion it also proved the best bar in the set; this was also the case for complete immersion in sea water and complete immersion in fresh water. In the Colombo series, with intermittent corrosion the 36 per cent. nickel steel " lost least in weight of all the bars in the set and was in very good condition generally." With complete immersion " slight localised corrosion had taken place on the general surface and at the edges, but large areas of original surface remained." A very satisfactory degree of resistance was also reported under a number of conditions for 3.75 per cent. nickel steel. The report contains a very comprehensive and detailed analysis on the the test data and is illustrated by about sixty photographs of the test bars after exposure.

Harn Chilled Alloy Irons

ALTHOUGH chilled cast iron has proved suitable for many purposes where high strength and resistance to shock is not essential, and although cast irons hardened by alloying and by heat treatment have considerably widened the scope of this type of material, there still remain certain applications where neither the hardness obtainable by chilling an ordinary cast iron, nor that which can be developed by heat-treatment of a grey cast iron, is sufficient. To meet this situation chilled alloy irons have been developed in which, with suitable compositions, a Brinell hardness of 700 or more may be obtained without sacrificing strength.

The alloy content required to produce extreme hardness in chilled iron depends largely on the rate of cooling which can be applied, and this, in turn, is determined by the size of the castings. For small parts, such as grinding plates of half-inch thickness, the total alloy content might be as low as 3.5 per cent., but for large castings an alloy content of 5.5 per cent. is necessary, since rapid cooling is impossible. As many other factors besides rate of cooling affect the chilling and heat-treatment characteristics, it becomes a little difficult to ascertain the best composition for any particular application, and with a view to elucidating the problem, experimental work has been in progress in the laboratories of the Research and Development Department of the Mond Nickel Co. The results of this research were given in a paper recently presented to the Institute of British Foundrymen by Mr. W. T. Griffiths, and have since been published in the form of a technical publication of the Bureau of Information on Nickel, entitled " The Production of Specially Hard Cast Irons by Alloying and Heat-Treatment." The author deals with the effect of varying percentages of nickel, chromium and other elements on the chilling characteristics of a low-carbon and high-carbon iron respectively, attention being given to the properties of both slowly cooled and of relatively rapidly cooled chilled castings, while additional information is included on the precautions to be observed in producing these irons of specially high hardness.

World Tin Consumption Statistics

AN increase of 28 per cent. in world tin consumption for the year ended February, 1934, compared with the previous year, is shown in the April bulletin of the Hague Statistical Office of the International Tin Research and Development Council. Tin consumption during the twelve months ended February, 1934, amounted to approximately 128,000 tons, as compared with 99,833 tons during the twelve months ended February, 1933, and with 129,003 tons during the twelve months ended February, 1932. A very considerable increase in the world production of tinplate is also shown; this for the twelve months ended February, 1934, amounted to approximately 3,150,000 tons, as compared with 2,290,000 tons during the twelve months ended February, 1933.

Monograph on Pure Iron

A MONOGRAPH on pure iron is being compiled at the United States Bureau of Standards in co-operation with the Iron Alloy Committee of the Engineering Foundation. Experimental results on the various properties of iron produced electrolytically and in other ways, and of varying degrees of purity, are scattered throughout German, French, English and other scientific literature. The assembly and critical review of the data from these studies supply the best available information on the fundamental or " base-line " properties of iron from which all the modern engineering uses of steels must be developed by the proper use of alloys with iron and of suitable mechanical and thermal treatments of such alloys.

Electrolytic Zinc from Blast Furnace Smoke

THE " Canadian Mining and Metallurgical Bulletin " for March contains a reprint of the paper prepared by W. M. Hannay and James Bryden for the annual general meeting of the Canadian Institute of Mining and Metallurgy held in Quebec in April, entitled " Electrolytic Zinc from fume produced from Trail Lead Blast-Furnace Slags." This description of the development and operation of the methods used in extracting zinc from the products of the slag fuming process completes the picture of the winning of metals from the by-products of the main processes used in obtaining the metals from the ore of the Sullivan mine at Kimberley, British Colombia. The manufacture of iron remains for the future, but a start has already been made, in connection with the manufacture of fertilisers, to utilise the sulphurous gases made in metallurgical processes. The bulletin in question can be consulted at the Reference Library, Canada House, Trafalgar Square, London, S.W.1.

The Present Trend in Metal Finishing

Mr. S. Wernick Discusses the Applicability of Modern Methods

METAL finishes used in modern architecture were the subject of a lecture which Mr. S. Wernick, M.Sc., Ph.D., delivered at the Building Centre, New Bond Street, London, recently, when he endeavoured to give information which might lead to a closer bond of sympathy between architects and builders, on the one hand, and metal finishers on the other hand.

Whatever the appearance of the finish, its serviceability will devolve on a few basic properties which it should possess, said Mr. Wernick. First of all, *it must adhere tenaciously* to the base metal, and resist strongly any attempt to detach it. The best type of bond between the finish and the base material is a chemical one, such as obtains with many types of electro-deposits and in certain other cases such as galvanising, where an alloy phase exists between the base metal and the coating. Such a deposit possesses truly remarkable powers of adhesion. Thus, it is possible to obtain nickel plating on steel which is so tenacious that in any attempt to part the deposit forcibly by applying very high tension the base metal will part from itself rather than at the juncture of base metal and deposit. Such nickel plating represents the best type of work which can be carried out in the plating shops to-day when every step of the process is carefully controlled. A second form of adhesion which is only inferior to a chemical bond is one of a mechanical nature. This occurs when the finish is interlocked between the interstices at the metal surface. To achieve this, the surface may be roughened by chemical etching or by sand-blasting or other suitable means.

Adhesion and Porosity

The presence or absence of adhesion is not a property which is always readily detected by mere inspection. One can imagine a rubber band fitted tightly over a tube or cylinder. Here is a case of attachment, but actually no adhesion at all exists. It is not at all uncommon in a plating, particularly upon certain metals such as aluminium and zinc, which owing to ready atmospheric oxidation, are difficult to plate. The plating appears securely attached to the base metal, but actually the true adhesion is poor. In due course, particularly if the deposit is also porous, the plating will peel away from the base metal. The *porosity* of the finish is another important factor in its efficiency, and this is practically as important as adhesion. The protection afforded to the base metal from corroding conditions depends largely on the degree to which the finish insulates the article from these conditions. Such conditions may comprise internal or external, rural, urban, marine or tropical atmospheres. A finish that is highly porous acts as a sieve and under certain conditions may be worse in its protective capacity than no finish at all, since it may result in intensification of corrosion at the pores.

Other essential properties of a metal finish are uniformity over the surface to which it is applied, which is not always easy to achieve in practice and also the existence of an adequate thickness of the coating to ensure reasonable wear and tear in service. The latter is largely bound up with the hardness or abrasion resistance of the finish. The extent of the *uniformity* of a finish is dependent on the particular process employed. Finishes applied by spraying are probably best adapted to ensure reasonable uniformity. It should be borne in mind, however, that certain electro-plating processes are inherently associated with lack of uniformity of the coating. Chromium plating in particular suffers from this defect and parts of complicated shape receive little or no chromium within hollows or recessed portions of the article. The "throwing power" is the property of the bath which determines the uniformity, and it so happens that the throwing power of the chromium plating bath is rather poor. Nickel plating is much more fortunate in this respect, while copper, zinc and cadmium and other platings give practically complete uniformity.

The war against corrosion proceeds without halt, and protective measures are now universally employed. The processes employed in preventing corrosion are also constantly increasing in number, although, basically, there are two main classes of coating processes, namely, the inorganic coatings, comprising metals and inorganic compounds; and the organic coats, which include paints, enamels, varnishes, and lacquers. Both classes are very extensively used, the organic type of protection being probably more widely employed as a structural finish, while metal finishes are more often used on the smaller articles of utility and decoration.

Mechanical Protection

Mechanical protection is achieved to a greater or less extent by all types of protective coatings through the production of a uniformly sound, non-porous, and perfectly adhering coating, the base metal being effectively insulated from the corroding conditions to be encountered from the surrounding atmosphere by an impervious envelope consisting of the material employed as the protective. Unfortunately, however, while perfect adhesion of the coating is readily achieved, few coating are perfectly uniform or free from minute pores, while even if they are initially produced in the ideally perfect condition, abrasion and wear in the course of service necessarily result in gradual deterioration and eventual exposure of the base metal.

It is at this stage that the electro-chemical protective effect which is only obtained when certain metallic coatings are employed, is invaluable. The following list of the normal potentials of a number of the metals commonly used as coatings for steel is taken from the electro-chemical series of elements, hydrogen being taken as zero: Copper 0.35, lead 0.13, tin 0.15, nickel 0.42, zinc 0.77. This list provides a ready clue to the electro-chemical relationship between any two metals selected. Thus, metals above iron in the table are cathodic to the latter, and therefore if used as coatings for ferrous materials will form electro-couples with the base metal at discontinuities, or when it becomes exposed in service, as a result of which the iron "enters solution"—namely, corrodes preferentially; in other words, corrosion is actually accelerated at discontinuities. Zinc and cadmium, on the other hand, are anodic to iron—that is, are more reactive, or have a greater tendency to enter solution than iron; accordingly these coatings corrode preferentially or "sacrificially" at discontinuities, simultaneously preventing the corrosion of the ferrous base. These metals are therefore electro-chemical as well as mechanical protectives. Both of them are used to a considerable extent in industry as protectives for ferrous materials.

Cadmium is a comparatively new-comer as a protective coating, but its closer proximity to iron in the electro-chemical series indicates less chemical reactivity than zinc or a lower corrosion rate. It is applied mainly as an electro-deposit or plating, and although coatings that are but a small fraction of a thousandth of an inch in thickness are all that is requisite, its rapidly increasing use has elevated this process from a laboratory experiment to an important industrial application.

Methods of Applying Metallic Coatings

Interest in the application of metallic coatings for rust prevention was very much quickened by the war, and as a result numerous methods of applying such protective coatings have been developed and exploited industrially within the last few years. The principal methods employed are (1) hot dipping, (2) electro-deposition, (3) vaporisation or cementation, (4) spraying, (5) chemical replacement, and (6) rolling. The first four methods are the most important. Chemical replacement consists in the immersion of the metal in a suitable solution of a chemical reagent, containing an electro-positive metal, there being a chemical interchange between the latter and the immersed metal, which receives a coating of the metal in the solution; this coating is necessarily very thin, since the replacement ceases as soon as the initial layer of the coating is produced, and therefore its protective value

is usually poor. Rolling, on the other hand, is an old process used to produce a thin coat of the more precious metals on a baser metal, and is not ordinarily applicable to cheap ferrous metals, even though the rolling of such common metals as nickel on base metals has been successfully achieved.

The hot dipping method, which as applied to zinc was known as long ago as 1741, is in very common use; tinned iron, too is widely used; the process cannot, however, owing to the electro-positive nature of tin, result in true rust prevention. While the galvanised coat provides excellent protection, it is probably the cheapest but not the best means of applying zinc to a ferrous surface. It owes its efficiency as a rust preventive to the thickness of the coating, which does not lend itself to ready control, and is of the order of from two to four-thousandths of an inch in thickness. The coating forms a true alloy with the iron surface, and a certain amount of the latter finds its way into the molten bath. The coating is therefore of necessity not one of pure zinc, such as is produced by electro-deposition.

Electro-Deposition

Electro-deposited coatings, the use of which has much increased in recent years, are, owing to the nature of the process, by far the purest coatings produced. Since the anodes, in the case of zinc and cadmium coating, are of high-grade purity, and the electrolyte contains the pure salt of the metal to be deposited, the deposit consists practically of 100 per cent. pure metal. Since, too, the deposit is " grown " at a uniform rate, the process is readily amenable to control, and almost any thickness of deposit is obtainable. An adequate thickness of deposit capable of providing very efficient protection is much smaller than with other processes, amounting to 0.0005 in. in the case of zinc plating and 0.0003 in. in the case of cadmium. The process has been developed in recent years so that it may be worked entirely automatically, the whole sequence of cleaning and preparing the metal, plating, washing, and drying being accomplished by a mechanical conveyor system in the course of a surprisingly short space of time.

The " vaporisation " or cementation process, which has also enjoyed increasing application in recent years, consists essentially in heating the articles to be treated while surrounded by the coating medium (which is usually in the powdered form) to a temperature which is not far below the melting point of the latter. As a result, vaporisation of the more fusible metal occurs, depositing upon the surface being treated and forming a closely adhering coating which consists of the alloy of the two metals at the junction, so that the coating becomes an integral part of the surface treated. There are various applications of this process; the best known is the " sherardising " process, which employs powdered zinc or a zinc-cadmium alloy in which the articles are packed in a heated, rotating drum. Aluminium powder is used in the " calorising " process; the resulting product in this case is highly resistant to oxidation by heat, and is therefore used in treating furnace bars, etc. Similarly, the "chromising" process thermally produces a coating of chromium. Very high temperatures, however, are requisite with these processes.

Metal Spraying

The most recently introduced process of all consists in the direct spraying of the coating in the form of the molten metal on to the surface being treated. A special " pistol " is used wherein the metal is fed as a ribbon or wire and the latter is ingeniously " atomised " by an ignited gaseous mixture, of either hydrogen or acetylene with oxigen or air, which passes through annular spaces in the pistol and is projected at high velocity by compressed air. The principal advantage of this method is the ready portability of the comparatively light spraying apparatus; hence the method is used widely for coating outdoor structures, such as bridges, tanks, tunnels, and ships in situ, where other methods would be out of the question. Practically all metals may be sprayed regardless of the melting point. Pure coatings can be applied, but owing to the high temperature used are subject to oxidation.

Brief consideration must now be given to the organic type of coating-paints, enamels, varnishes, lacquers, etc. Only mechanical protection can, generally speaking, be provided by such coats, and hence such factors as perfect adhesion, uniformity of coating, and freedom from imperfections are even more significant than with metal coats. Yet, how common is the spectacle of a painter liberally applying paint to an iron surface from which the grease has been removed but superficially, and the rust and scale thereon is still plainly discernible. Undoubtedly, more than 50 per cent. of corrosion failures in painted steel structures arises not through insufficient or inefficient paint, but through the inefficient preparation of the surface before painting. If, however, the surface has been efficiently cleaned—and sand-blasting may have to be resorted to in really obstinate cases of heavy scale—the nature of the primer which is first applied plays a very considerable part in the ultimate protection achieved by the paint. It must act as an efficient " key " for the next coat, be of a " dehydrating " character, and at the same time possess rust-inhibiting properties.

Choice of Primers

Primers are usually basic in nature; those containing lead, zinc, iron, and cadmium oxides are best for the purpose. The lead pigments are well known and are probably as efficient as any in use to-day; where spraying is employed and red lead is considered undesirable, its place can be taken by iron oxide, which, though less effective, is nevertheless a definite inhibitor. The zinc pigments are probably better and compare quite favourably with the lead variety; for one thing they combine very readily with the other constituents of the primer, the resins and oils, owing to the definitely acid nature of the latter, and form somewhat complex compounds, which are beneficial alike both from the point of view of the cohesion of the primer and the protection it provides.

Cadmium pigments have somewhat similar properties, and are efficient inhibitors; they are at present very favourably regarded; a disadvantage is their comparatively high cost. Recently aluminium paint has evoked considerable attention not only as a primer but also as an undercoat and finishing coat. It has been stated that it is even superior to red lead, if properly applied. It owes its corrosion-preventing properties largely to a " leafing " effect, small flat particles of aluminium metal overlapping and entirely covering the base metal.

The " following " coats to be applied in painting largely depend on the type of corrosion which the finish is to encounter eventually. Thus, for ironwork which is underground, where the corrosive influences are stagnant or running water, decaying vegetable matter, soluble gases, etc., a " water-proof " type of coating is best, and bituminous coatings are probably pre-eminent in this class. Ironwork on the ground, on the other hand, which must withstand rain, soluble salts, and atmospheric constituents, as well as rapid changes of temperature (for example, occurrence of ground frost, etc.) requires an elastic oil coating possessing a tightly packed film. Lastly, ironwork above ground, which encounters very severe conditions, requires a paint of the " long oil " variety, namely, a paint containing a high content of oil relative to the pigment content. So much for the finishing of ferrous metals.

Chromium Plating

Non-ferrous metals are ordinarily not so readily corrodible and so the protective aspect is not usually so highly important. For example, whereas a nickel deposit on steel should be specified to be at least one-thousandth of an inch thick, on brass or copper it need not be more than half this thickness or even slightly less. The finishes on non-ferrous metals may again be either inorganic or organic. In the latter connection, very beautiful effects are obtainable to-day either in multicolour or resulting in a cracked, or crystalline, appearance which attractively breaks up the surface. Lacquers may be either of the stoved or airdrying (nitro-cellulose) variety. In general, stoved finishes are likely to prove more protective, although excellent durability may be achieved with a reputable type of air-drying material.

Chromium plating, where it is properly applied or when it is preceded by a good deposit of nickel, is a deservedly popular finish on brass articles. The user of chromium plating should specify an adequately thick undercoating of nickel if he wishes to obtain maximum service for this finish. Poor

chromium plating is as often as not due to the faulty coat of nickel underneath it as to any other cause. The thickness of the chromium deposit itself is not of very great importance provided that the nickel undercoat is substantial. In fact, most chromium plating represents a very thin veneer, not much more than 0.00005 inch thick, which is deposited upon a relatively thick deposit of nickel. In effect, the nickel represents the protective bulwark and the chromium contributes the superficial decoration; and the durability of the latter depends largely on the adequacy of the former. A complaint which is fairly common among users of chromium plated fittings which require to be exposed (for example, metal used on shop front fittings) is that it tends to become covered with a brownish deposit in course of time. It is not generally known that this may be avoided and the brightness practically indefinitely maintained by the simple expedient of wiping the finish over at regular intervals, say, weekly, with a damp cloth. The formation of the brown stain, which is largely due to trapped chromium electrolyte, is by these simple means prevented.

The Finishing of Aluminium

Over thirty times as much aluminium was produced in 1930 as in 1900. The metal has obvious attractions for the architect and builder in view of the lightness and excellent structural qualities of many of its alloys, and its ready working and fabricating properties. Although a number of alloys have been produced which are able to stand up fairly satisfactorily to atmospheric corroding influences, really effective corrosion resistance can only be obtained by the application of an adequate finish. Unless such a finish is provided, an unsightly surface appears in due course while under severe corroding conditions, as for example, in marine atmospheres, serious corrosion occurs which may result in the ultimate failure of the article exposed.

While aluminium may be successfully plated with other metals under very careful conditions, and it may also be enamelled or lacquered, such finishes in general are not found to be greatly corrosion resistant. It is also difficult, owing to the ready oxidation of aluminium in the atmosphere, to provide a coating which will not strip or peel from the surface in due course, owing to the poor adhesion usually achieved. The most successful methods of protecting aluminium and its alloys, utilise the principle that it is the existence of the thin oxide layer on the surface which prevents aluminium from being one of the most corrodible metals extant. Such processes may be purely chemical as well as electrolytic, but the type of coat obtained cannot be thickened by purely chemical means to any great extent.

The anodic oxidation processes, as the electrolytic methods are commonly known, utilise a suitable electrolyte in which the article to be treated constitutes the anode of the circuit. As a result a coating of aluminium oxide forms, which possesses remarkable properties. Not only does it impart very considerable corrosion resistance to the article treated, but under certain conditions, extremely hard coats are produced which are highly abrasion resisting and therefore increase the wear resistance of the article to a very appreciable degree. The oxide film which has mordanting properties can also be coloured by the use of suitable dyes and highly pleasing decorative effects may be achieved by these means. The oxide coat, which is integral with the base metal and does not therefore strip or peel if correctly applied, is also electrically insulating.

Application of Anodising

The application of anodising is not new by any means. The investigation of the artificially produced oxide film on aluminium dates back to the middle of last century, while its industrial use commenced some ten years ago when it filled a highly important role as a protective for aircraft parts—a role it is filling quite satisfactorily to-day since practically all aluminium parts on aeroplanes are so treated now. The anodising process introduced by Bengough and Stuart in 1924 provides an excellent corrosion resistant coating, but the process suffers from certain drawbacks, principal among which is the fact that only a limited range of alloys are amenable to the treatment. As many industrial alloys contain comparatively high quantities of the heavy metals, this is a serious disadvantage. Further, the process is not a continuous one and the operating conditions, for example, voltage employed and time of treatment, are far from ideal. The difficulty of treating and particularly colouring castings by the Bengough process constitutes a further drawback. These difficulties have largely been overcome by one or two anodic processes which have appeared subsequent to the Bengough process. It is now possible to treat practically the whole range of aluminium alloys rendering them highly resistant to corrosion and to colour quite 90 per cent. of them satisfactorily.

Iron and Steel Institute

Annual Meeting

THE annual meeting of the Iron and Steel Institute will be held at the Institution of Civil Engineers, Great George Street, Westminster, S.W.1, on Thursday and Friday, May 31 and June 1, commencing each day at 10 a.m.

Papers to be presented for discussion on Thursday, May 31, include:—W. A. Bone, F.R.S., H. L. Saunders and N. Calvert, "An Experimental Inquiry into the Interactions of Gases and Ore in the Blast-Furnace. Part III. Proposed Methods for Comparative Testing of Iron Ores." W. A. Bone, F.R.S., H. L. Saunders and J. E. Rushbrooke, "An Experimental Inquiry into the Interactions of Gases and Ore in the Blast-Furnace. Part IV. Equilibria and Velocities in Ore Reduction." "The First Report of the Blast-Furnace Practice Sub-Committee," to the Iron and Steel Industrial Research Council. Blast-Furnace Linings. Part I. An examination of the information received in reply to a questionnaire circulated to iron manufacturers, by A. T. Green. Part II. Some Properties of the Fireclay Products Used for Blast-Furnace Linings, by A. T. Green, W. Hugill, F. H. Clews and H. Ellerton. J. Sarek, "Principles of the Design of Blast-Furnace Lines." J. G. Pearce, "The Elasticity, Deflection and Resilience of Cast Iron." W. E. Hoare, "Tin-Iron Alloy in Tinplate with Notes on Some Imperfections." W. D. Jones and W. E. Hoare, "A Microscopic Examination of Iron-Tin Reaction Products."

The annual dinner of the Institute will be held at the Connaught Rooms, Great Queen Street, on May 31, at 7 p.m.

On Friday, June 1, announcements will be made of the award of the Andrew Carnegie Research Scholarships for 1934-35; the Carnegie Gold Medal for 1933 (Mr. Brynmor Jones), and the Williams Prize for 1933 (Mr. A. Robinson and Mr. D. F. Marshall).

Papers to be presented for discussion on Friday, June 1, include "Second Report of the Corrosion Committee," to the Iron and Steel Industrial Research Council. E. R. Mort, "The Manufacture of Full-Finished Steel Sheets." E. Maurer and W. Bischof, "The Behaviour of Sulphur in Open-Hearth Furnace Gases." L. Northcott, "Dendritic Segregation in Steel Ingots." L. Northcott, "A Study of Ingot Structures." L. Northcott, "Periodic Structures in Metals and Alloys." E. C. Rollason, "The Effects of Cold-Rolling on the Intergranular Corrosion of the 18/8 Austenitic Steels." D. Hattori, "The Thermal Conductivity of Tool Steel."

Autumn Meeting, 1934

The autumn meeting will be held in Belgium and Luxemburg, by the kind invitation of the iron and steel manufacturers of those countries. The date for the opening of the meeting has been fixed for Monday, September 10. The session for the reading and discussion of papers will taken place in Brussels on the mornings of Monday and Tuesday, September 10 and 11. Visits will also be paid to the industrial centre of Belgium, including on Wednesday, September 12, an excursion to Liége. On the evening of Wednesday, September 12, the party will travel to Luxemburg, where arrangements are being made to visit the chief iron and steel manufacturing plants of that country. Negotiations are in progress with the railway authorities concerned for the members resident in the United Kingdom to leave London by special train on Saturday, September 8, arriving in Brussels the same evening. Members resident on the Continent may find it more convenient to travel independently to Brussels. The complete programme will be announced at a later date.

Zinc Ashes and Galvanising Residues

A Process for Recovering Chlorine Products

MOST zinc ashes and residues from galvanising baths are washed to remove soluble chlorine products, so that no losses will be subsequently sustained in the remelting of the metal values. An alternative process consists of recovering these wet products so that they may be brought to saleable condition. The latter method is not so widely known, since it is necessary to work these wastes on a much larger scale to justify a greater outlay on plant, and thus ensure a complete recovery. In the former process, the residues are simply charged into a large vat, or several vats, and allowed to soak in water for indefinite periods. This is done to eliminate the chlorine products as far as possible, and the large amount of liquor obtained is run to waste.

Zinc ashes and skimmings from galvanising baths contain chlorine in appreciable quantity, not only in the form of zinc chloride, but also in the form of undecomposed ammonium chloride. Where large consignments of this can be obtained regularly, efforts are made to recover all these soluble products without exception. The exact composition of the zinc wastes is seldom completely ascertained as it necessitates a very involved chemical analysis. It is generally taken to consist of zinc chloride, zinc oxide, zinc oxychloride, and ammonium chloride.

When it is intended to work up this waste material by a wet process the galvanisers are requested to transfer their wastes to shallow trays whilst they are still in heated condition. If this is not done the mass scraped off the zinc surface tends to form a hard and tough material, which requires to be specially broken up prior to passing into the ball mill. The skimmings are placed on trays and periodically emptied, and the broken mass transferred to a loose heap, and preferably packed in casks whenever cold, for despatch to the recovery works. One of the principal reasons why the wet process was abandoned by many small metal refiners was because of the complications which arose when the skimmings are first moistened with water. What happens is that unless specially treated, the free ammonium chloride is dissolved, and at the same time zinc chloride, and also zinc oxychloride are also dissolved. By further diluting the liquor with water, a voluminous precipitate of combined hydrate and oxychloride of zinc is formed, and there are other complications. The somewhat gelatinous nature of the precipitate can cause the remaining untreated particles of solid matter to become coated, and prevents the solvent action continuing. For this reason, certain large-scale washing treatments were abandoned, or altered to meet this exigency. Various experiments were also done in the way of charging the molten material directly into water, spraying it into water, and granulating it by other means.

Construction of the Plant

The plant involved to make a complete recovery is so constructed that the ammonia is evolved, passed up a condenser containing hydrochloric acid and ultimately obtained as ammonium chloride. A form of wet ball mill is used. The zinc wastes are pulverised and converted to the form of an emulsion at the one treatment. The coating of the particles with freshly formed hydrate is thus avoided, and a slide with perforated screens and wire gauze allows the emulsion to be discharged in the desired condition. The insoluble material is principally pellets of metallic zinc, and when the raw material has come from ordinary metal refining firms, small pieces of coal ash and coke are also present. The amount of chlorine is then ascertained, and a fixed addition of milk of lime is made to effect the necessary decomposition. This is done by calculation, and it is important that an excess of lime be added. The density of the liquor is tested, and also that of the milk of lime.

Several hours are required for the agitation. The ashes and residues vary widely in composition, and the time allotted is calculated according to a pre-arranged scale, as taken from previous experiences. In this way no undue lengthy period of agitation is involved, and, on the other hand, few instances arise where an imperfect solution results. The residual matter, consisting principally of pellets of metallic zinc, is smelted.

The milk of lime is added in the necessary proportion by a test of the density, and the mixture is transferred to an improvised form of still. The still is heated by live steam which causes the ammonia, and also part of the water to be evolved. The gaseous matter is passed into a crude condenser consisting of a length of selected drain-pipe packed with porous material. The pipe selected was several feet in diameter, and placed in an upright position. On top of this, a small stoutly built wooden box was fitted to contain the dilute hydrochloric acid. The acid was caused to pass into the condensing arrangement in the form of a fine spray, and a release system allowed the excess gas to escape. Several pipe lengths were used, which in appearance resembled a tower-condensing system.

The Products of Distillation

The products from the distillation of the mixture of zinc waste liquor and milk of lime chiefly consist of steam and ammonia gas, which on coming in contact with the dilute hydrochloric acid, become converted to ammonium chloride in dilute solution. Various measures have been adopted to endeavour to reduce this dilution as far as possible, so as to minimise the amount of subsequent evaporation. The action in the condensing towers is seldom absolute so far as neutralisation is concerned, and complete neutralisation requires to be done when the liquor issues from the bottom of the condenser. The ammonium chloride liquor is then transferred to an evaporator, and the salt crystallised out. The mother liquors are utilised by returning to the box at the top of the condensing towers, and in some cases one pipeline is supplied with this liquor alone, so that the gas and steam from the still meet this first, prior to reaching the towers with the dilute hydrochloric acid.

When boiling down in an iron pot it is necessary to keep the solution slightly alkaline by frequent small additions of dilute ammonia. This is done in order to counteract the dissociation which takes place, and whereby the neutral liquor tends to become slightly acid. It is, however, considered best practice in works engaged on ammonia manufacture, to crystallise from a slightly acid solution. The object is to offer to any ferrous salts, which may be in solution, an opportunity to become oxidised to the ferric condition. So far as the recovery of ammonium chloride for galvanising purposes is concerned, no such exacting details are followed, and it is simply desirable to see that the liquors are crystallised out, and the crystals transferred to bags for use.

The residues remaining in the still after the distillation process have been completed, consist chiefly of zinc oxide and calcium chloride. If the exact proportion of lime could be added to remove all ammonia gas, and also ensure the residue consisting of only these two materials, a very thorough separation could thus be effected, but in practice it is always necessary to employ an excess of lime. The residual matter, therefore, consists of crude zinc oxide containing a small amount of lime, and a solution composed principally of calcium chloride. The mass is passed through a wooden filter press, and the crude zinc oxide is washed until free from chlorides.

An Increased Demand for Selenium

THE anode slimes and residues produced during the electrolytic refining of copper now constitute the chief commercial source of selenium. In 1931 the Ontario Refining Co., of Canada, recorded an output of 21,500 lb. of the element, but it is believed that production has since been very considerably increased by reason of the demand for selenium in the glass and photo-electric industries. Sodium selenite is chiefly used for the decolorisation of bottle glass.

Metallurgical Section

June 2, 1934

Recovery of Sulphur Dioxide from Smelter Gases

THE recovery of sulphur dioxide from smelter gases is the subject of a patent recently granted to Dr. M. C. Boswell and Mr. G. P. Beal, of the University of Toronto. The process had its origin following investigations which established a very efficient method for the reduction of sulphur dioxide with water gas, using an iron, nickel or cobalt catalyst which functioned at temperatures as low as 180° C. and with great rapidity at 300° C. Applying this reaction to the direct reduction of sulphur dioxide in smelter gases, a difficulty arose due to the presence of free oxygen, which had to be used up before the reaction would proceed. It therefore seemed logical to isolate the sulphur dioxide before submitting it to the reducing process, and Dr. Boswell and his associates began to investigate the possibility of various methods of extraction.

Whilst it seemed possible to wash the smelter gases with water and ultimately drive off the sulphur dioxide, the low partial pressure of the sulphur dioxide in the smelter gases made it necessary to use enormous amounts of water, and in consequence such a method could not be put into practice. Aniline, however, was found to be a material which took up large quantities of sulphur dioxide. Here, again, there was a disadvantage to be overcome, in that the reaction between aniline and sulphur dioxide produced normal and acid sulphites which settled out as solids, and it was considered undesirabe to handle solid material. It was then found that the addition of lactic acid would keep the precipitates in solution. As outlined in the patent the extraction process consists in washing the smelter gases with a mixutre of aniline and lactic acid, and ultimately liberating the sulphur dioxide in a very pure and dry condition by the application of heat. It is stated that the plant required is simple in construction, the aniline and lactic acid are inexpensive, loss of gas during the washing process is very small, and the heat necessary to liberate the sulphur dioxide is not excessive.

Zinc Dust in Gold Recovery Practice

SOME useful information regarding the difficulties which are encountered in the precipitation of gold by zinc dust, and the subsequent treatment of the precipitate, is given in a recent publication of the United States Bureau of Mines. At the Golden Cycle Mill, Colorado, zinc shavings contained in zinc boxes were formerly used for the precipitation of gold from cyanide solutions, but since 1929 zinc dust has been used. The solutions are passed through vacuum equipment before precipitation and the barren solution (which contains 0.02 oz. of gold per ton) flows into sumps and is used as wash solution for both sand and slime treatments. When zinc shavings were used for precipitation, the zinc boxes were cleaned up by removing the contents and treating the precipitate with sulphuric acid in a tank. When most of the zinc had dissolved, the sludge was dropped into a small air-tight tank, and from there forced by air pressure into a small clean-up press. The gold sludge was washed in this press with hot water for the removal of zinc sulphate; the press was then dismantled, the sludge cake removed, and charged into a muffle type furnace. This muffle was brought to a red heat and most of the lead and any remaining zinc was oxidised, the roasted product being ultimately fixed with a flux consisting of silicious sand (2), sodium bicarbonate (2), borax glass (1) and fluorspar (1), in the proportion of 84 lb. of flux to 100 lb. of residue.

When the change from zinc shavings to zinc dust was made, the sulphuric acid treatment was discontinued. The precipitate, after removal from the press, was then put into iron pans and mixed whilst still wet with sodium nitrate in the proportion of 125 lb. of precipitate to 25 lb. of nitrate, the pans and their charge being subsequently raised to a red heat in a furnace equipped with cast iron muffles. Here the drying and sintering of the charge was effected and it could be handled without loss of dust. Subsequently the sintered mass is mixed with the flux already mentioned and melted.

Columbium in Nickel Chromium Steels

EXPERIMENTS on a number of chromium-nickel steels having varying percentages of chromium, nickel and carbon, with or without the addition of columbium, tantalum and other corrosion-inhibiting elements, have been recently reported in Technical Publication No. 519, of the American Institute of Mining and Metallurgical Engineers. Intergranular corrosion tests were made on samples of sheet, quenched from 1,150° C., heated (for periods varying from one hour to five months) at temperatures within the range 300°—900° C., and subsequently boiled in acidified copper sulphate solution for a minimum of 200 hours or 10 failure. The behaviour of certain of the low-carbon plain nickel-chromium steel, in which loss of impact strength and susceptibility to intercrystalline corrosion were not affected in parallel degree by given treatments, suggests that a twofold problem occurs in the use of the nickel-chromium steels at elevated temperatures, *viz.*, loss of toughness, and susceptibility to intergranular attack. In the region of 650° C. both defects occur and may even intensify each other. The addition of columbium, in varying ratio to the carbon content, showed that

improvement in resistance to intergranular corrosion was progressive, until, with a ratio of columbium 10: carbon 1 the steels showed no disintegration after exposure for long or short periods at all temperatures between 300° and 800° C.

Except in the case of low-carbon steels, columbium does not markedly improve toughness on exposure in the range 650°—900° C. Critical point determinations on a columbium-containing steel showed that the material expanded and contracted normally on heating and cooling, being free from changes occurring in straight nickel-chromium austenitic steels. The substantial elimination of thoses changes may in part explain the efficacy of columbium in inhibiting intergranular corrosion. Physical and mechanical tests on the straight nickel-chromium and the columbium-bearing steels showed that their properties are in no sense impaired by the modifying addition and salt spray and boiling 65 per cent. nitric acid tests proved the complex steels to be possessed of excellent corrosion-resisting qualities.

High Temperature Steam Plant

THE experience gained from high temperature steam equipment in power plants operated by the Detroit Edison Co. in the United States, has led to the conclusion that the design of steam power plant using temperatures as high as 1,100° F. is feasible if suitable materials of construction are employed. In a recent paper on " High Temperature Experience at Detroit " (" Engineering," December 15 and 22, 1933), Mr. P. W. Thompson and Mr. R. M. van Duzer state that the selection of materials for the experimental plant which they describe was made solely on the basis of the maximum efficiency in the light of existing knowledge of the behaviour of materials under high temperature steam conditions. They also give an account of the considerations on which the selection was based, and of the behaviour of the materials of the various components from metallurgical as well as purely engineering viewpoints.

A nickel-chromium-molybdenum steel was chosen for the turbine throttle valve, the high pressure shaft packing case, the inner and outer high-pressure cylinders and the forged rotor cylinders. A steel containing nickel 36, chromium 12, carbon 0.47 per cent. was used for the first stage blading of the turbines: shaft packing was of forged Monel metal. Nickel alloys were also employed in the jointing and bolting components. Austenitic nickel-chromium steels of various types were extensively employed, *e.g.*, for part of the radiant section, piping, loose companion flanges, valve and desuperheater castings. On account of the experimental character of the installation, close and frequent inspection has been carried out and a detailed account of these observations is given in the paper. With only very minor exceptions, entirely trouble-free working of the plant is reported, but increase in cost of maintenance attributable to the high temperature steam has been negligible. It is urged that, in view of the continued progress in metallurgical high temperature research, it should be possible in the not too distanct future to produce high temperature materials at a price which would give economic justification for the general use of steam at 1,000° F.

Weathering of Sheet Aluminium

INVESTIGATIONS on the corrosion of aluminium and its alloys in sheet form have been in progress at the United States Bureau of Standards since 1925. The chief object in view has been to study and develop methods for the elimination of corrosion embrittlement in those alloys which are used for aircraft construction, particularly duralumin. Corrosive attack of the intercrystalline type is most undesirable in sheet aluminium alloys since it results in serious embrittlement. The attack is particularly insidious, because it may be difficult to find on the surface even when it has penetrated the metal to a considerable degree, following the path of the crystal or grain boundaries.

The results of tests of duralumin carried out by the Bureau may be practically eliminated if certain procedures are followed in heat treating the material. The standards indicate that intercrystalline attack in sheet treatment recommended involves heating at a temperature of about 505° C., followed by quickly quenching in cold water. The reheating of heat-treated duralumin at temperatures between 100° and 300° C. renders the material susceptible to the intercrystalline attack. This attack tends to penetrate sheet duralumin much more rapidly than the usual pitting. The latter develops in material which is properly heat-treated and tends to spread on the surface rather than to penetrate. Losses in the tensile properties, after the same length of time of exposure to the weather, are much greater with material that is susceptible to the intercrystalline attack than with material on which only pitting is present. Slight differences in chemical composition, or small amounts of cold-working, are less important in influencing the rate of corrosive attack than is the method of heat treatment. Invariably, corrosive attack proceeds at its most rapid rate within the first two years of exposure to the weather. Thereafter, to the conclusion of a 5-year exposure period, further losses in tensile properties were seldom in evidence.

Sands for Foundry Use

Recommended Methods for Testing

RECOMMENDED methods for testing and control of foundry moulding sands are the subject of Research Report No. 108, which has just been published by the British Cast Iron Research Association.

In Research Report No. 73, issued in May, 1930, the Association published full details of methods of testing for foundry moulding sands for both research and foundry control purposes, which had been adopted in the investigations carried out on this subject by the Association over a period of five years. In view of the desirability of the widest possible adoption of the methods of testing found most suitable for general use, the Council of the Association approved of the recommendation of the Sands and Refractories Sub-Committee that this Report should be made generally available to those interested. As a consequence the edition was rapidly exhausted and this re-issue has provided an opportunity for incorporating various additions and modifications.

Apart from variations in the inherent properties of new sands used in mixtures, the personal factor for each foundry, which embraces, among other things, its history, its moulders, their training, the standard of quality required, and the methods of moulding used, must be evaluated before specifications for facing sands can be given with the degree of certainty that is necessary to-day, and towards which progress is being made.

The Trend of Metallurgical Research

Work at the National Physical Laboratory, Teddington

THE annual report of the National Physical Laboratory for the year 1933, in-so-far as it relates to the Department of Metallurgy and Metallurgical Chemistry, makes reference to the preparation of pure metals. A quantity of iron was prepared by the decomposition of purified ferrous chloride by means of steam and subsequent reduction in hydrogen of the oxide obtained. The reduced product was sintered, briquetted and melted, treated in the molten condition with hydrogen, and again melted *in vacuo*. Some of this iron was then cold-rolled, without annealing, from 1½ in. down to ½ in. diameter round rod. A comprehensive analysis of this iron shows it to be superior in purity to any previous product.

Excluding oxygen, the total impurities amount to only 0.012 per cent., the chief impurities being carbon, 0.0045 per cent., and manganese, 0.003 per cent. Nickel—a persistent impurity in previous high-purity irons—has been reduced to 0.0006 per cent. Accurate determinations of a number of physical properties, such as density, thermal expansion, and thermal and electrical resistivity, have been carried out during the past year, and preparations are in hand for accurate thermal and dilatometric analysis. Attempts have also been made to determine the influence of small traces of impurities on physical properties, such as magnetic permeability.

Special Refractories

As in previous years, it has again been necessary to devote a considerable amount of study to problems relating to refractory materials arising in the course of a number of researches. The routine production of crucibles, tubes and other apparatus which, by reason of the special materials used or of particular requirements of design, cannot be obtained from external sources, has been continued. Special apparatus in pure thoria and alumina has been prepared for the Physics and Electricity Departments and has proved satisfactory for use in contact with molten platinum, paladium, etc., in work on the black-body radiator as a standard of light. These refractories have also been used extensively in researches at high temperatures on metals and alloys of high purity.

Particular attention has been devoted to the production of highly refractory impervious materials. This work has been continued on the lines indicated in the report of the Laboratory for 1932. Although it has not yet been possible to produce tubes of pure recrystallised aluminia which are completely gas-tight, the permeability to gases of this type of body, prepared by heating specially treated alumina at temperatures exceeding 1,900° C., is extremely low. The material is finding a widespread application in many researches by reason of its resistance to corrosion, low gas absorption and good thermal endurance. It has been used successfully for crucibles under severe chemical and thermal conditions, as a material for thermocouple protecting sheathing, and in researches on gases in metals, where a substantially impermeable refractory must be utilised. Insulators of this material have also been used in superheated steam, at a pressure of 800 lb. per sq.. in. and at 500° C., for 100 hours, without showing signs of corrosion, and are not disintegrated after repeated use under these conditions with frequent rapid reduction of the pressure to zero.

Microchemical Analysis

Qualitative microchemical analysis has continued to be used mainly in connection with corrosion products. Progress has been made in the quantitative analysis of small quantities. Satisfactory results have been obtained with some non-ferrous alloys using samples of 2 mg. to 5 mg. Arising out of the experience thus gained, modifications in apparatus have been made and new apparatus has been designed.

A new development is the study of the distribution of constituents in metal ingot. By a contact printing process it has been possible to show the distribution of bismuth in a copper ingot containing as little as 0.02 per cent. free bismuth. In connection with the examination of the segregation of this constituent in copper ingots, a colorimetric method using thiourea has been worked out for the quantitative determination of bismuth in samples of copper weighing only 1 g. and containing 0.02 per cent. to less than 0.001 per cent. bismuth. The distribution of bismuth in an ingot containing 0.02 per cent. bismuth was explored by the use of this method.

The routine estimation of quantities of bismuth of the order of 0.001 per cent. in copper presents difficulties, and great discrepancies are found between the results of different analysts. This subject has, therefore, been investigated during the past year, and it has been found desirable to isolate the bismuth in the form of a pure compound before applying the colorimetric iodide method. Bismuth phosphate has advantages for this purpose, being, unlike the phosphates of other metals present in copper, practically insoluble in dilute nitric acid. The accuracy of the colorimetric iodide method has also been increased by reducing the iron with sulphur dioxide and boiling off the excess before adding iodide. In this way much smaller amounts than 0.001 per cent. bismuth may be accurately determined.

Use of Quartz Spectrograph

The quartz spectrograph has been used with a logarithmic sector for the quantitative analysis of powders, compressed into pellets and heated between the electrodes of an arc between metal rods. The behaviour of some pellets containing alumina, silica, etc., was found to be very irregular, the character of the light emitted varying with the position of the crater of the arc. The relative intensities of lines due, for example, to aluminium and iron may change enormously with little visible change in the mode of burning of the arc. Many expedients have been tried to secure reproducibility, without being able to ensure success; fortunately, if several photographs are taken, the general appearance of the spectrum allows those plates to be rejected in which standard conditions do not exist. To improve the stability of arcs burning between metal electrodes for spectrographic purposes, a small generator has been installed in the room, converting the available 110 volt supply to 240 volts.

Aluminium Alloys

During the past year the work on light alloys has been continued for the Metallurgy Research Board in accordance with the programme recommended by the Alloys Sub-Committee of the Aeronautical Research Committee. A study is now being made of the age-hardening of a series of copper-aluminium alloys containing silicon and iron in varying amounts. At the same time their constitution is being determined at temperatures of 500° C. and 200° C. respectively, by means of the micro-examination of quenched and slowly-cooled specimens. The method of removing dissolved gases from aluminium and its alloys by passing a mixture of nitrogen and the vapour of a volatile chloride through the molten metal has been adopted as a routine method for the production of sound metal. The temperature of the metal does not, in itself, appear to exert any influence on the process up to 850° C., but when gas furnace melting is employed, the risk of recontaminating the metal with gas increases as the temperature rises. The question of the contamination of the metal with hydrogen obtained from moisture in the crucible has also been examined. The plumbago crucibles which are widely employed in practice have been found to contain considerable quantities of water, some of which is released only at a slow rate even at high temperature. The material which has been dried by heating also rapidly re-absorbs moisture when exposed in the cold to the atmosphere.

The determination of the solubility of hydrogen in aluminium has been attempted in (1) an all-silica apparatus with a hydrogen jacket surrounding the tube containing the metal, (2) an apparatus in which the metal is contained in a refractory clay tube, and (3) an apparatus in which the metal is

held in a clear-silica tube enclosed in a steel gas-tight tube containing hydrogen. The first apparatus led to explosions and was therefore abandoned. The second proved to be useless owing to the slow absorption of hydrogen by the refractory tube. The third has just been completed, and is proving much more hopeful, and it is expected that measurements will be made in the immediate future.

The study of the factors controlling the grain size of cast aluminium has been continued. While treatment of the metal with a volatile chloride and nitrogen, which removes dissolved hydrogen, leads to the development of a coarse structure, further treatment with hydrogen does not in all cases cause a reversion to a fine structure. The purity of the gas and of the metal appears to be involved.

Non-Tarnishing Silver

As indicated in the report of the Laboratory for 1933, the programme of research on minor metals has now been concluded with the termination of the investigation of the effects of small additions of beryllium to standard silver. These alloys have been shown to possess a very high tarnish resistance to sulphur compounds, and form the subject of British Patent No. 399,261, of 1933. A full description of the preparation and properties of these alloys, together with the results of a complete redetermination of the constitution of the silver-beryllium system, has been prepared for publication.

The determination of the solubility of hydrogen in pure iron has been continued, but it has not been found possible to obtain accurate values. Progress in the production of pure alumina crucibles substantially impervious to gases has helped to remove certain of the difficulties previously described, and it is now possible to melt iron in a vacuum of the order of 0.0001 mm. without contamination with oxide. The experiments conducted with a molybdenum-wound furnace have shown that the refractory tubes available for the work are not sufficiently gas-tight at the melting point of iron. It is essential to obtain a furnace capable of maintaining a high vacuum and constancy of volume at 1,550° C., and with this in view, a small furnace has been constructed which promises to fulfil these conditions to a certain degree.

Properties of Metals at High Temperatures

The work on the fundamental study of alloys has been continued for the Committee on the Behaviour of Materials at High Temperatures. This study of the mechanism of deformation and failure of materials under prolonged loading has largely been carried out by the use of creep apparatus designed to work *in vacuo* at temperatures up to 1,000° C. The specimens have been tested in the polished and etched condition, so that changes of the microstructure on the surface could be observed. Tests on certain commercial materials have been completed prior to a study of the mechanism of failure of pure iron and synthetic iron-carbon alloys. The materials tested have comprised mild steel, Armco iron, Swedish iron, carbonyl iron and wrought iron, while material having a coarse grain size has also been studied. In addition, the effect of age-hardening on creep resistance in materials which exhibit this phenomenon is being studied, in view of the relationship previously observed in the complex nickel-chromium-iron alloys investigated at the Laboratory. Creep tests on the behaviour of soft metals indicate that metals such as tin, zinc, cadmium, lead and aluminium, at room temperature, behave in a somewhat similar manner to alloys of iron at higher temperatures.

Gas Cylinders

In view of the fact that liquid iron carbonyl has been found to accumulate in cylinders used for the storage of carbon monoxide or of mixtures containing that gas under pressure, an investigation has been begun at the request of the Home Office with the object of determining whether this results in any deterioration of the steel, such as the development of intercrystalline brittleness. Cylinders which have been used for carbon monoxide for long periods have been sectioned and their structure is under investigation.

The investigation on carbon and other alloy steels for use at high temperatures has been continued under the auspices of the Joint Committee of the British Electrical and Allied Industries Research Association and the National Federation of Iron and Steel Manufacturers. The object of the research is to obtain more suitable materials for the construction of boilers, superheaters, turbine rotors and other parts exposed to high temperatures and pressures. A series of plain carbon steels varying in carbon content from 0.10 per cent. to 0.60 per cent. has been made by various processes, such as acid open hearth, basic electric furnace, etc. These steels have been investigated after various heat treatments designed to modify the microstructure. In addition, a series of steels has been supplied containing 0.5 per cent. and 1 per cent. of molybdenum, and these materials have also been tested after various heat treatments. A further series of steels containing 0.5 per cent. molybdenum is being prepared, each containing proportions of other alloy elements, with the object of eliminating the intercrystalline type of failure at high temperatures in this type of steel.

Strength of Carbon Steels

The work already carried out has indicated that there exists a considerable degree of variability in the creep strength of carbon steels of identical chemical composition. The two series of steels tested, which contain 0.15 per cent. and 0.40 per cent. carbon respectively, appear to show a greater degree of abnormality within each series than exists between the average values of the two groups. The investigation of the molybdenum steels clearly shows that this element produces a marked strengthening action. The steels are probably as strong at 550° C. as carbon steels at 450° C.

Considerable experience has now been obtained in the manipulation of the high pressure boiler for work on the effects of superheated steam. In the work on the effect of flue gases tests have been completed on eight steels in a synthetic flue gas mixture containing 0.07 per cent. sulphur dioxide at 500° C. and 600° C. The tests have included measurements of the change in electrical resistance and breaking load due to the corrosion of the samples, together with micro-examination and measurements of the thickness of the scale.

Impurities on Copper

The work for the British Non-Ferrous Metals Research Association on the effect of impurities on copper has been continued with special regard to the distribution of impurities in ingots on a works scale. Copper manufacturers are assisting the Research Association and the Laboratory by preparing and sectioning ingots of copper of the various types used in industry, including round billets, rectangular flat "cakes" and vertical "cakes," containing known amounts of impurities, and by carrying out rolling and other working tests under works conditions on companion ingots to those sectioned.

In the course of the investigation into the distribution of impurities in vertical median sections of works ingots, attention has been given to developing methods of chemical analysis less laborious and tedious than existing gravimetric methods, for the accurate determination of small percentages of certain impurities, *e.g.*, bismuth. The opening up of new sources of copper within the Empire has emphasised the need for accurate knowledge of the effects of small amounts of impurities, such as bismuth, on copper, and for sound and reliable methods for determining the quantities present. Methods of determining small amounts of bismuth which have been developed at the Laboratory in the work on copper have recently been submitted to the British Non-Ferrous Metals Research Association and to the Fiscal Policy Technical Sub-Committee of the Brass and Copper Industries.

In addition to this section of the work, research has shown that the influence of added elements depends not only on their ratio to oxygen, but also on the presence of other impurities.

The introduction of a second and third element may displace the equilibrium in the copper in such a way as to render an impurity, which in the presence of oxygen would be comparatively harmless, free and able to exert a harmful influence. In this connection the relations between impurities such as bismuth, antimony, nickel and arsenic, in the presence of oxygen and a large excess of copper, are of great importance and are being further studied.

Some Notes on Corrosion Resisting Alloys

By H. SEYMOUR

DURING recent years several new corrosion-resisting alloys have been evolved, in some cases to meet a special problem, and in others in the effort to achieve a metal which will give good service over a wide range of conditions. One such alloy which is produced in a wide variety of forms is chromium iron; it is sold under various names and contains different quantities of the essential ingredients.

Generally speaking the new chromium irons which consist of about 17 per cent. chromium, with less than 0.10 per cent. carbon, are ductile, non-hardening alloys with an excellent resistance to general corrosion and oxidation at high temperatures. The physical properties are about equivalent to a high-grade medium carbon steel, *i..e*, the ultimate strength is approximately 80,000 lb. per sq. in., the yield point is 50,000 lb. per sq. in., and the elongation in a 2 in. length is some 26 per cent. Those figures apply to the annealed sheet form. An alloy of this type can be recommended for applications where a ductile, workable alloy with high-corrosion resistance is required, and a properly prepared and polished surface shows a high resistance to attack by atmospheric agencies. It also has a high resistance to nitric acid and to organic acids in foodstuffs.

Welding Properties

These alloys may be welded by the acetylene torch or the electric arc. Spot and resistance welding can also be done without difficulty, but forge and hammer welding are not possible owing to the fact that this type of analysis is subject to considerable grain growth as a result of the high welding heat. They can be soldered without difficulty, and strong joints are produced. A satisfactory flux for brazing may be made by mixing four parts of borax with one part of ferric chloride by weight in a solution of zinc chloride, made by dissolving zinc in muriatic acid to form a thick paste, and applying a small quantity of this to the parts to be brazed before heating.

A series of chromium-iron alloys Defirust, Defiheat, Defiacid and Defistain has been made by the Darlington Rustless Steel and Iron Co., Ltd., using the " Wild " direct chrome ore reduction process. The makers claim that their product shows a homogeneity hitherto unobtainable. It is soft, malleable and can be cold-worked without any difficulty; the surface of the finished material, moreover, is remarkably free from impurities and other imperfections and can easily be brought to a high lustre. Corrosion resistance is also outstanding and is claimed to exceed not only the high carbon-chrome-iron alloys, but shows greater resistance than low carbon-chrome-iron alloys of an equal analysis made by the ferro-chromium addition method.

Resistance to Oxidation

Another alloy of this type is one containing 25 to 30 per cent. chromium and less than 0.20 per cent. carbon, which can be used for temperatures up to 2,000°F. with good resistance to oxidation. This type of alloy, however, has a tendency to lose strength at high temperatures and should not be used where great strength and toughness are essential. It certainly possesses excellent corrosion-resisting properties and is specially recommended for acid mine waters, mixed acids and sulphur gases at high temperatures. It is suitable for furnace parts, glass moulds, annealing boxes and other high temperature uses.

In the series of silicon-iron alloys, there is Duriron, evolved in America but now handled in England by Sir S. W. Royse & Co., Ltd. The composition of this alloy is so balanced that it gives the maximum acid-resisting qualities combined with reasonable transverse strength and resistance to shock, but it is produced in castings only. Nevertheless, wherever corrosive liquids or gases are encountered, its usefulness is generally recognised, and the varied and insistent demand for dependable equipment to meet these conditions has resulted in the development of apparatus which has been designed with particular reference to unusual and severe operating conditions. This alloy is too hard to machine with ordinary cutting tools, although certain machining operations can be performed by the use of some of the new special steels; the usual finishing operations on Duriron are accomplished with grinding equipment. The alloy can be welded by the oxyacetylene flame, but careful preheating and cooling of the parts are essential to the success of the welding operation. Special welding rod is also used, and the resulting weld can then be just as acid-proof as the remainder of the casting.

Acid-Resistance of Nimol

Another interesting anti-corrosion alloy is Nimol, made by Monel-Weir, Ltd. This is a cast iron containing about 20 per cent. Monel metal, and is claimed to have the mechanical qualities of toughened grey cast iron combined with the corrosion resistance of high grade brass at a substantially lower price than the latter; it also possesses pronounced resistance to heat oxidation up to 600°C. Comparative corrosion tests with Nimol and cast iron show that the former possesses a greatly improved resistance to both sulphuric and hydrochloric acid, but it is not strongly recommended for nitric acid.

It has also been shown that Nimol loses only 1/100th the weight loss of cast iron in contact with a 5 per cent. aqueous solution of sulphuric acid; that when exposed to a 10 per cent. equeous solution of hydrochloric at room temperatures the rate of attack on Nimol was equivalent to 1/16 in. per year of continuous service; and that, when immersed in a solution of calcium hypochlorite sp. gr. 1.05 containing 29.4 grams of available chlorine per litre, the loss in weight of Nimol was one-tenth that of cast iron.

A Copper Base Alloy

Everdur, a copper-base alloy, was developed by the Du Pont Company of America to meet certain corrosison problems existing in some of their own plant operations which involved the use of hydrochloric acid, as the corrosion-resistant alloys and metals then available were not found sufficiently resistant to be of service. Further tests developed the fact that this metal was highly resistant to a large number of other corroding liquids; that it had a tensile strength considerably above acid-resistant bronze (comparable with steel and Monel metal); made sound castings; possessed excellent machining and working qualities; and could be fabricated into various forms. These features led to the decision to offer the alloy to industry in general. It machines about the same as brass and bronzes and much more readily than steel or Monel metal; it may be annealed and softened at temperatures between 1,250° and 1,400°F. and may be welded by the oxy-acetylene flame, as well as brazed and soldered. Its heat conductivity is approximately one-third that of copper.

It should be noted, however, that " Everdur " is unsuitable for nitric acid, but it is about equal to the nickle-copper alloys in resistance to sulphuric acid, except that nickel-copper alloys frequently show pitting effects, especially in sand castings, due probably to lack of homogeneity of the metal, while corrosion of Everdur is uniform and free from pitting.

Advantage of Uniformity

Uniform corrosion, of course, is much less damaging to the life of equipment than pitting corrosion. It can be used for equipment for handling chlorine and bleaching powder solutions, also for bisulphite and sulphurous acid and hydrogen peroxide solutions. Its resistance to these solutions makes it available for the paper, pulp, and general bleaching industries. The alloy also exhibits a peculiar behaviour toward metallic mercury and mercury solutions. Samples submerged in the solution of mercurious nitrate used by the U.S. Navy Department in testing for defective condenser tubes (100 grams of mercurous nitrate and 13 c.c. of concentrated nitric acid per litre) for three months show only a superficial surface amalgamation. Samples in a bath of metallic mercury for three months also showed no amalgamation.

Some Recent Metallurgical Patents

Magnesium Alloys

MAGNESIUM and magnesium alloys are melted or refined in the presence of a flux containing in addition to magnesium halides, with or without alkali halides, also manganese compounds having a high oxygen content, particularly Mn_2O_3 or MnO_2 or both. (See Specification No. 404,563, of P. Briske and V. Prohl, Berlin.)

Preventing Oxidation of Magnesium

READILY oxidisible metals such as magnesium or magnesium alloys are protected from oxidation while in a molten condition by maintaining in contact with the surface of the metal an atmosphere containing fluorine or the vapour of a fluorine compound which may be a compound containing fluorine and any of the following elements: Antimony, arsenic, bismuth, boron, bromine, carbon, chlorine, hydrogen, iodine, nitrogen, oxygen, phosphorus, silicon, sulphur, tin, and titanium. Ammonium borofluoride, silicofluoride, bifluoride, and fluophosphate are referred to as examples of suitable compounds. (See Specification No. 404,518, of Dow Chemical Co., Michigan.)

Deoxidising Steel

IN a process for deoxidising steel by means of a molten non-basic oxide-extracting slag, the slag is used in such fluid condition and the slag and molten metal are subjected together to such violent turbulence that an emulsion-like mixture of slag and metal is produced. The metal may be rapidly poured on to a very fluid slag or the latter may be poured into the mixing receptacle simultaneously with the rapid pouring of the metal. The slags used comprise silicic acid lime and alumina rendered very fluid by the addition of soda or silicia acid lime and soda. The slag after use is revivified for further use by treatment in a furnace with a reducing agent, *e.g.*, carbon and the molten metal may be recarburised prior to treatment with the slag. The purified metal may be treated with small proportions of aluminium in the ingot moulds. (See Specification No. 407,300 of Soc. d'Electro-Chimie, d'Electro-Metallurgie, et des Acieries Electriques d'Ugine.)

Coating with Metals

IRON castings are converted into malleable iron and provided with a hard surface layer resistant to oxidation at high temperatures by heating them to a temperature between 800° and 1,150° C. in contact with a mixture of aluminium, alumina, one or more carbides of a metal or metalloid, *e.g.*, calcium carbide or carborundum, and preferably also a small proportion of anhydrous chromic chloride. Air is excluded during the heating and is preferably expelled by the addition to the mixture of 1—2 per cent. of ammonia chloride. After heating for from 3—5 hours the castings are allowed to cool slowly. A surface layer is formed comprising an alloy of iron, aluminium, and the metal or metalloid of the carbide, together with chromium if chromic chloride is included in the mixture. (See Specification No. 404,180, of A. Folliet and N. Sainderichin, Paris.)

Purifying and Refining Steel

IN a process for dephosphorising steel by means of a molten oxidising basic slag, the slag is used in such fluid condition and the slag and molten steel are subjected to such turbulence that an emulsion-like mixture of metal and slag is produced. The process may be carried out by pouring the steel rapidly into a receptacle, such as a ladle, at the same time as the slag. The metal after treatment may be treated again in a similar manner with the slag. In carrying out the process in a convertor, the steel is dephosphorised in the usual manner, the blast stopped and the oxidised slag removed. A molten fluid oxidising basic slag is now charged over the steel and the blast resumed for a short period to effect turbulent intermixing previous to running. A slag comprising 3 per cent. by weight of silica, 65 of lime, 20 of iron oxide and 12 of fluorspar is referred to. (See Specification No. 405,633, of Soc. d'Electro-Chimie, d'Electro-Metallurgie, et des Acieries Electriques d'Ugine, Paris.)

Distilling Zinc

IN a process for the dis illation of zinc and similar metals, the reduction and vapourisation are carried out in a vessel, which may be a rotary muffle made of or having an internal surface of nickel or cobalt or a nickel or cobalt alloy, for example, a nickel-chromium-iron alloy. (See Specification No. 404,569, of F. Krupp Grusonwerk Akt.-Ges.)

Cleaning Metals

ORGANIC sulphoxides are added as inhibitors to acids in pickling processes or in any process in which metals are subject to the attack of acids. Benzylsulphoxides, diphenylsulphoxide, and dialkylenesulphoxide such as diphenylenesulphoxide, polymeric diethylenesulphoxide, and thianthrenesulphoxide are referred to. A wetting, emulsifying, or frothing agent such as saponin or alkylnaphthalene sulphonic acids or their salts may be added, particularly when the sulphoxide used is not readily soluble. (See Specification No. 405,690, of I.G. Farbenindustrie.)

Case Hardening

IRON, steel and alloy steels are case-hardened by treating them in a fused salt bath contaniing 30—60 per cent. by weight of barium chloride and 10—20 of sodium cyanide, the balance consisting essentially of alkali metal salts such as chlorides or carbonates which are added for the purpose of lowering the melting point ad increasing the fluidity of the mixture. The treatment is carried out at a temperature below 900° C. Small amounts ot exceeding 5 per cent. by weight of strontium or magnesium salts may also be added to the bath. In an example the bath consists of a mixture of 55 parts of barium chloride, 25 parts potassium chloride, 20 parts of sodium chloride and 20 parts of sodium cyanide. (See Specification No. 406,346, of Roessler and Hasslacher Chemical Co., New York.)

Titanium and Tungsten Alloys

ALLOYS of titanium, tungsten, chromium, etc., are made by the exorthermic reduction of their oxides by a melted mass containing iron, carbon, aluminium, silicon, calcium, magnesium, or their compounds, or mixtures of these reducing substances, in such a manner that with appropriate fluxes a fluid slag is produced at a low temperature. The mass may be deprived of the superposed slag and put into reaction with a new oxidising mixture to enrich the mass with the desired metals. For making non-oxidising alloys the process may comprise the two stages of exothermic reduction of oxide containing material to produce a ferro-chrome high in chromium, and the incorporation of the ferrochrome with molten iron under a protective slag. (See Specification No. 405,245, of V. Angelini, Milan.)

United States Molybdenum Industry

Statistics for 1933

THE mine production of molybdenum ore in the United States in 1933 amounted to 705,000 short tons, which yielded 5,348 short tons of concentrates carrying 5,627,700 lb. of metallic molybdenum. The output consisted of 704,235 short tons of molybdenite-bearing ore which yielded 5,327 short tons of concentrates averaging 87.93 per cent. (9,368,400 lb.) of molybdenum sulphide (MoS_2) containing 5,621,000 lb. of metallic molybdenum; and 765 short tons of wulfenite-bearing ore which yielded 21 short tons of concentrates averaging 23.96 per cent. (10,000 lb.) of molybdenum trioxide (Moo_3) containing 6,700 lb. of metallic molybdenum. In 1932 the production was 363,400 short tons of ore which yielded 2,387 short tons of concentrates averaging 84.89 per cent. (4,052 lb.) of molybdenum sulphide (MoS_2), equivalent to 2.431,000 lb. of metallic molybdenum. Concentrates shipped from mines in 1933 contained 5,707,000 lb. of metallic molybdenum with an estimated value of $4,276,000, compared with 2,373,000 lb. in 1932 with an estimated value of $1,186,000.

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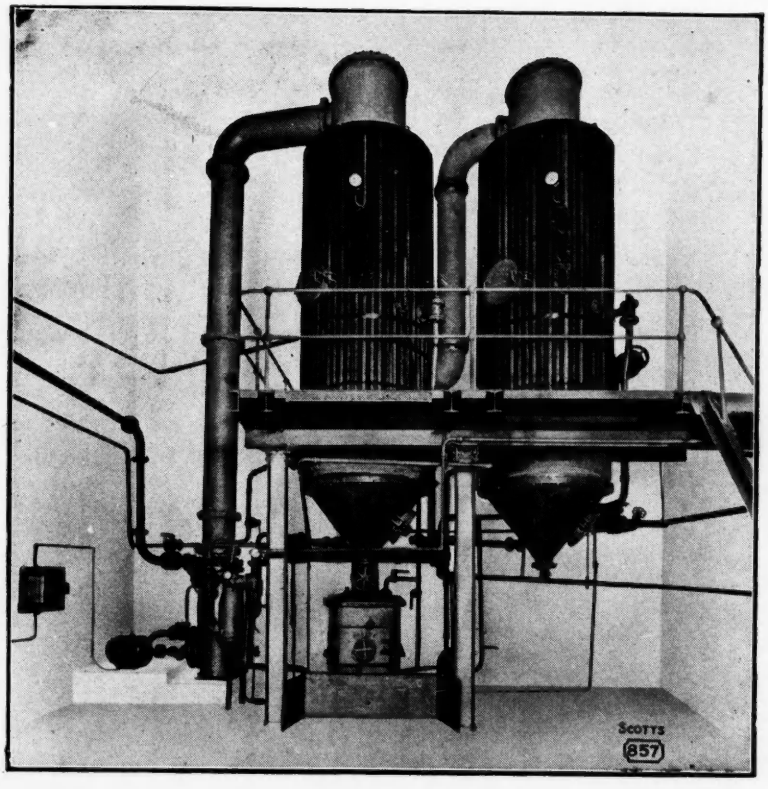

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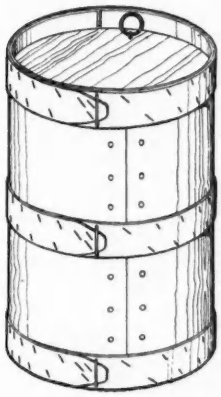

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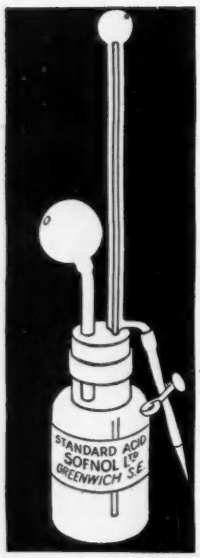

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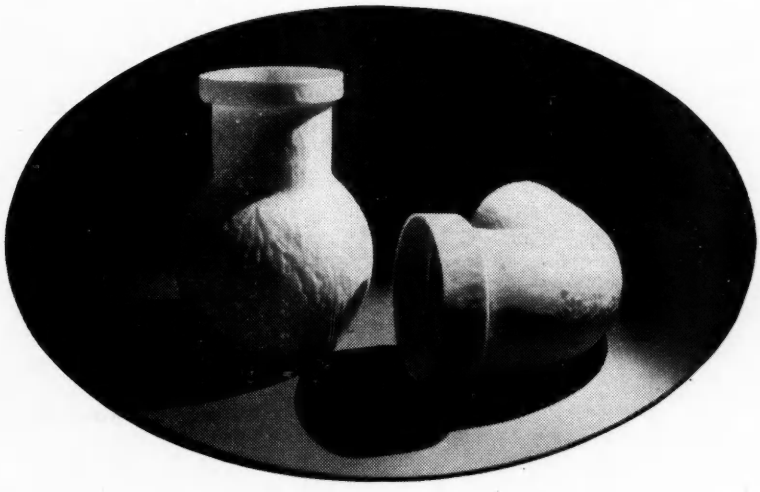

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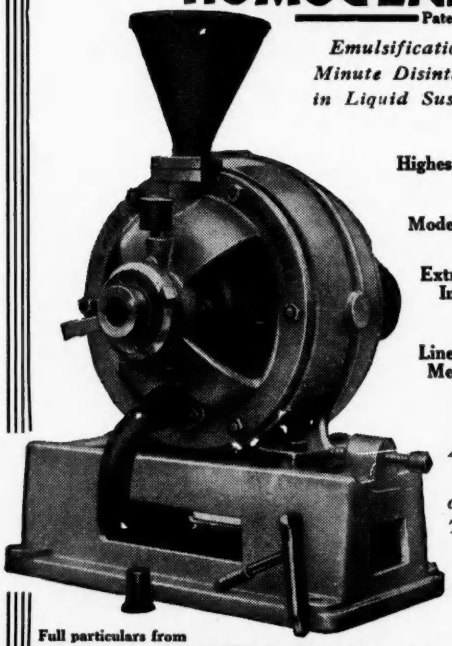

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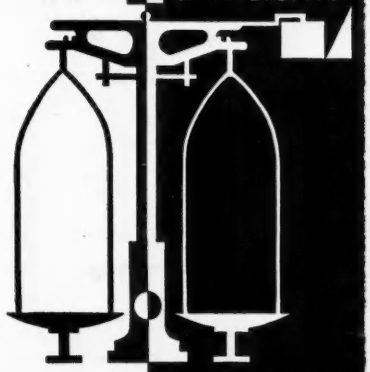

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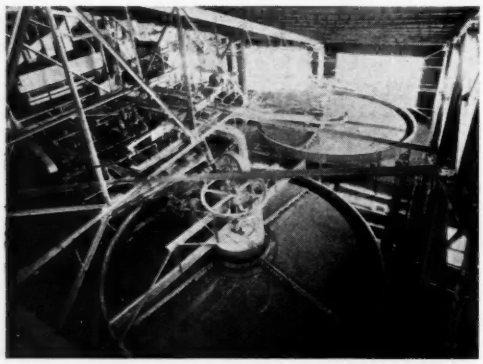

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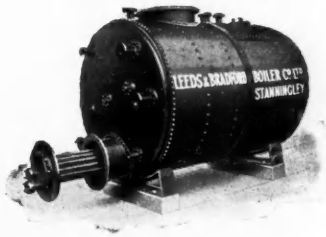

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